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THREE PARSONS TRANSFORMERS

The photograph shows three transformers for New Zealand, forming a 10,000 kVA. 110/11 kV., 3 phase bank. On load voltage regulating equipment is fitted to the L.V. side to give a +6% to −14% variation on the H.V. side. Joints on these transformers are made with Langite.

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"We shall defend our island whatever the cost may be. We shall fight on the beaches, we shall figh
landing grounds, in the fields, in the streets and in the hills. We shall never surrender."—Mr. Chur

SAVING SCRAP VITAL TO WINNING WAR

WE are still wasting thousands of tons of scrap material that could be used to help win the war.

Mr Herbert Morrison, Minister of Supply, appealed yesterday to everyone to do more to help salvage this material.

"Metals, paper, rags, food waste and bones, unromantic as they may seem, are of vital importance for our war effort," he said.

"It is essential that they should be recovered and put to good use in increasing quantities."

SALVAGE DRIVE

The Minister knows that many people are anxious to help, find difficulty in getting their waste collected.

"That is one problem that will be tackled by the committees of councils of P.s appointed by him this week to assist in the salvage drive.

Meanwhile, Mr. Morrison urged yesterday that every individual should take steps to ensure that everything possible in his or her possession or passing through their kitchens should be put at the disposal of the country.

He told as an example to be followed of the offer by Countess Roberts, daughter of the late Field Marshal Earl Roberts, to place at the country's disposal all the many trophies of war which came to her father.

These include field guns and cannon from every one of his campaigns.

INSPIRING LEAD

"Let the whole country accept it as a lead," said Mr. Morrison, "and let the spirit prevail in us which is at the bottom of the offerings will be worthy that inspires the whole country.

"Our own dumps of 20,000 collieries and industry throughout England and Wales will be organized by the Iron and Steel Control of the Ministry of Supply in the next few weeks.

"The aim of the scheme is to collect at least 50,000 tons of metal by voluntary effort which would otherwise never reach the furnaces."

Speaking of the production of [illegible] the Minister said that [illegible] splendid response [illegible]

R.A.F. BOMBERS ATTACK BRIDGES

Vivid flashes of green, red and yellow up to a height of 4000 feet were seen when one of an R.A.F. night bombing formation scored a direct hit on what appeared to be an important German munitions dump, says Associated Press.

The objective was inside Germany near an important bottle-neck by which enemy supplies and reinforcements cross the Moselle into Luxemburg and Belgium.

Within split seconds of the detonation of the bombs the dark night sky was streaked with a continuing series of flashes.

During a series of daylight raids on a strategic road and railway in North-Eastern France medium bombers scattered strings of bombs along the permanent way and swooped low to machine-gun German anti-aircraft post, at the roadside.

A wood concealing an anti-aircraft battery was showered with bombs. A column of motor transport was attacked.

ALL SAFELY BACK

All the aircraft in this operation returned safely.

Another formation of more than 30 bombers attacked cross roads, railway bridges an important junction and a town where German troops were known to be concentrated in the south-east corner of Belgium.

Although scores of searchlights swept the sky and the bombers were peppered with anti-aircraft fire, some swept as low as 400 feet, some machine-gunning two trains.

Again all the aircraft returned safely, although one had to make a forced landing, without damage, behind the Allied lines.

The pilot who yesterday attacked a munitions dump, an aquadron-leader, led the attack of last week's raids and for three days ran a form after another, covering for six hours.

10 BRITISH SHIPS SUNK IN A WEEK

Half Average Losses

Mercantile losses due to enemy action during the week ended midnight on Sunday, May 26, amounted to 45,225 tons, it was officially announced to-day.

British losses were ten ships—representing about half the average weekly losses during the war.

Total tonnage of the ships lost were: British, 10,914 tons; four Allied ships, 12,906; four neutrals, 21,405.

Losses include two hospital ships—the Brighton and the Maid of Kent—which were sunk by aircraft.

The small tonnage lost is due to the fact that most of the vessels were of less than 1000 tons.

The total of the known and estimated German mercantile losses remain substantially unaltered at 830,000 tons.

Up to May 19, 22,171 British, Allied and neutral ships had been convoyed in British convoys, with a loss of only 47 ships—or at a loss ratio of 1 in 715.

Neutral ships convoyed numbered 4121, with a loss of three giving a loss ratio of 1 in 1040.

"BEGRUDGE NOTHING"

To the Editor of The Daily Telegraph

Sir,—Let everyone who is saving [illegible]

20 Fight 80—And Bag 12

OUTNUMBERED four to one, a squadron of Britain's latest fighters, Boulton-Paul Defiants, brought down 12 German machines over Dunkirk yesterday.

Eleven Defiants, accompanied by nine Hurricanes, took off from an aerodrome in the South-East of England just after lunch, says the European United Press.

When they were over Dunkirk 80 Messerschmitts of the 109 type were sighted beneath them, and the Defiants and Hurricanes dived to the attack.

SURPRISE SWOOP

Before they had had time to fire more than a few rounds all were Germans—Messerschmitt 109s and Heinkel fighters—swooped down on them.

The Defiants and Hurricanes kept firing until their ammunition was exhausted.

"A MIRACLE OF DELIVERANCE"

BY OUR OWN REPRESENTATIVE

WESTMINSTER, Tuesday.

Never has a Prime Minister more magnificently matched himself to a great occasion than did Mr Churchill this afternoon. In a speech which lasted only 34 minutes he unfolded to the House of Commons the story of "a miracle of deliverance" for which he had not dared himself to hope when he warned them last week to be prepared to face "hard and heavy tidings."

Making no attempt to minimise the consequences of a "colossal military defeat," unflinchingly facing the possibilities, even darkest, of the future, the Prime Minister ended with a peroration which will be quoted and remembered throughout the Empire for its resolute determination.

His speech was punctuated with cheers, but his claim to speak for the House and the nation needed no such justification.

He began by a reappraisal of the Sedan break-through, and revealed that the original French plan of closing the gap had to be abandoned in face of the force of the German penetration.

EPIC OF CALAIS
Surrender Call "Spurned"

The defence of Boulogne by the Guards was ended by orders from this country. Calais was defended to the last by the Rifle Brigade, the 60th Rifles, and the Queen Vic torian Rifles with a battalion of British tanks and 1,000 French troops—in all about 4,000. The British Brigadier had "spurned" the German demand for surrender.

Four days of intense street fighting passed before a silence reigned over Calais, which marked the end of a memorable resistance.

Thirty unwounded survivors were brought off by the Navy. The remainder, their comrades, were unknown. But they had not been in vain. Their resistance had engaged two German armoured divisions and thereby enabled the Gravelines waterline to be flooded and held by the French. Thus it was, said Mr Churchill, that the port of Calais played its full part in the general scheme.

ARMIES

[illegible] speaking of the production of [illegible] the Minister said that [illegible] splendid response [illegible]

Leopold's defection, which exposed our whole flank and means of retreat. At short notice the British had to cover their 30-mile flank to the sea and in doing so lost contact with two of the three French corps.

"Now it seemed impossible that any large number of Allied troops could reach the coast.

AIR FORCE VICTORY
"Out of Jaws of Death"

Mr. Churchill paused. "Not suddenly, the scene is clear," he said. "A miracle of deliverance has been achieved by valour, perseverance, perfect discipline and faultless service. The skill and resource and unconquerable fidelity is manifest to all. The enemy is hurled back by the retreating British and French troops. It was so roughly handled that it dared not molest their departure."

He went on to speak of the triumph of the Air Force, which had defeated the main strength of the enemy Air Force and inflicted losses of at least four to one.

The pent-up cheers burst out at the Prime Minister's announcement, which followed, that "over 335,000 men, French and British, were carried out of the jaws of death to their native land and to the tasks which lie immediately before them."

The note of warning followed at once. This was not a victory. Wars are not won by evacuations. Yet there was a victory within the deliverance. It belonged to the Air Force.

PILOTS VINDICATED
Superiority Over Enemy

"All our types and all our pilots have been vindicated," Mr. Churchill continued. "The Hurricane, Spitfire and the new Defiant all have been vindicated as superior to what they have to face. Triumphant under these conditions, their prospects when defending their native air would be greater. I must say that I find in these facts a sure basis for practical and reasonable [illegible]

Returning to the [illegible] revealed, [illegible]

THE B.E.F. NEEDS YOUR SCRAP!

"Give us more tanks, planes and equipment and we'll beat them next time!" said B.E.F. heroes returning from Dunkirk.

The country is working overtime to produce those tanks and planes, but it must have more steel. More steel means more scrap—and you have some of that scrap iron and steel in your works. Clear it out—every bit of it! Not only process scrap, but old machinery, obsolete spares, rusty junk of all kinds—it must be sold at once to the scrap merchant. Think of our troops and the equipment they need—only a continuous supply of scrap will keep them supplied, but you must do something about *your* scrap *now*—it's urgent! If in any difficulty write at once to Iron & Steel Control, Steel House, London.

GERMANS RUSH GUNS TO COAST

From WALTER FARR, Daily Mail Correspondent

PARIS, Tuesday.

GERMAN advance detachments to-night were busy consolidating their position in ruined [illegible]

PREMIER PREDICTS ANOT BLOW AT THE ALLIES SO

By E. CLEPHAN PALMER
The Parliamentary Correspondent

THE full gravity of the military position was brought before the H mons last night by the Prime Minister in a speech of matchless compromising candour and indomitable courage.

Sometimes he sent a chill through the crowded House, as when he "colossal military disaster" in France and Flanders, and of our deter defend our island home and ride out the storms of war . . . if necessa if necessary, alone." He was grim then.

He stressed, however, that the British Empire and the French Republic, linked defend to the death their native soils.

Always the darkness of the picture he drew was relieved by his faith in the people of Britain—his confidence that, whatever happened, they would refuse to accept the possibility of defeat.

Even if the worst happened—

"We shall defend our island whatever the cost may be. We shall fight on the beaches, we shall fight on the landing grounds, in the fields, in the streets, and in the hills. We shall never surrender."

The House did not cheer. It was, it seemed, a moment for something deeper than cheers. The tense silence was unbroken till Mr. Churchill said:

"Even if—which I do not for a moment believe—this island or a large part of it were subjugated and starving, then our Empire beyond the seas, armed and guarded by the British Fleet, will carry on the struggle until, in God's good time, the New World, with all its might and power, steps forth to the rescue and the liberation of the old."

HELP WELCOMED

The moving phrases were certainly [illegible] but so also, were two arguments of the first importance at the present time. One, that those American [illegible] who believe any assistance they can send us would arrive too late [illegible]—they will still find us [illegible]

[illegible] that with the best will in the [illegible] disgraceful gaps in our defences [illegible] with those honourable [illegible] the evacuation from Dunkirk [illegible] be made good for some [illegible]

[illegible] during that time the [illegible] expected to strike with [illegible] possible vigour, assured [illegible] doubly welcome immediately.

ANXIETY

[illegible] Minister's reference to [illegible] fighting alone has [illegible] a lot of anxious [illegible] his tributes elsewhere to France.

[illegible] it is presumably the [illegible] has lost more [illegible] and perhaps is [illegible] have, and may [illegible] bear almost the [illegible] German offen[illegible] from the rear [illegible] Italians.

[illegible] in Spain of [illegible] will very [illegible] support of all [illegible]

[illegible] economic stranglehold makes [illegible] more and more difficult for him to replace his weapons of war.

"Hitler knows he cannot stay the course. If his swiftly repeated hammer blows fail, he has failed.

"That is not so with us.

"Hitler is biting on granite, for we possess mighty resources which have not yet been fully tapped."

R.A.F. Record: 78 in a Day, 169 in Week-End

BRITISH fighter pilots destroyed or severely damaged 169 German planes over Dunkirk during the week-end.

Between dawn and 7 p.m. on Saturday their bag was 78, a record for one day's work. Yesterday they shot down 35 and possibly another six. On Friday they destroyed 56. These are Air Ministry official figures.

A French authorised source stated last night that Allied fighters shot down 149 German machines over Dunkirk on Friday.

Eight R.A.F. fighters were missing after yesterday's operations; 16 after Saturday's and 14 after Friday's.

Ships Attacked

Here is the story of the R.A.F.'s record on Saturday as told to an Air Ministry statement last night.

"Squadron after squadron of Hurricanes and Spitfires flew high above the French fore air day guarding the convoys which were bringing the B.E.F. rearguard home.

"Huge formations of Nazi bombers

Rhone Valley Raided

GERMAN planes which on Saturday bombed Marseilles and other towns in South-East France resumed their raids in the [illegible]

Churchill Ass United Stat

By VERNON BARTLETT

AMONG diplomats in the Gallery the Prime Minister's speech in the Hou was one of unreserved welcome.

Several of them had feared that he mig the temptation to disguise the magnitude under moving phrases about the heroism tion with which the B.E.F. faced up to it.

Such an attitude would have convinced many neutrals, including those in the New World to whom Mr. Churchill appealed in his concluding sentence, that the British public was still considered too weak for any diet but the soft, soothing, reassuring lies it received from the previous Governent.

NAZI LO THE

SEIZ[illegible] ON RE

FALSE

BY SAISON

The claim ma[illegible] German [illegible] Sunday's opera[illegible] are now to Al[illegible] destroyed or d[illegible] Air Ministry [illegible] exaggeration.

Reports of th[illegible] German air force[illegible] operations [illegible] 500 aircraft. [illegible] claim to be wel[illegible] they are based [illegible] rather than upo[illegible]

Even admitting [illegible] the high degree of [illegible] claimed, [illegible] by the R.A.F. [illegible] inside, serious [illegible] enemy's reserves [illegible] and.

There is no d[illegible] Dunkirk area tha[illegible] a numerically s[illegible] been possible for [illegible] there in one [illegible] numbers.

No such [illegible] achieved, while [illegible] by the Allies [illegible] smaller actio[illegible] total loss.

CONVOY

It should no[illegible] the coming days [illegible] extent of [illegible] Dunkirk [illegible] the air waves as [illegible]

On economic stranglehold makes [illegible] more and more difficult for him to replace his weapons of war.

"Hitler knows he cannot stay the course. If his swiftly repeated hammer blows fail, he has failed.

"That is not so with us.

"Hitler is biting on granite, for we possess mighty resources which have not yet been fully tapped."

Secret Sessio on B.

Home Defe

By WILSON B[illegible]
Daily Mail Correspo[illegible]

ARRANGE[illegible] being mad[illegible] session of the H[illegible] mons on Tuesda[illegible] will enable a f[illegible] sion to take pla[illegible] pects of the pres[illegible] ation as empha[illegible] Prime Minister [illegible]

Mr. Churchill [illegible] greeted the secret[illegible] gained the admi[illegible] House of Commons [illegible] ness and boldness [illegible] the gravest[illegible]

He once again [illegible] by his frank appre[illegible] situation, his refusal [illegible] friendship and bel[illegible] A new B.E.F. is to [illegible] to serve in France [illegible] will continue to be [illegible] of France.

Ending Fifth [illegible]

"GO TO IT!" Herbert Morrison

A Seven-Day Journal

Compulsory Salvage Collection

FROM time to time in this column we have recorded the progress made in the collection of salvaged materials under the scheme inaugurated by the Ministry of Supply under the leadership of Mr. H. G. Judd, the Salvage Controller. On taking office Mr. Herbert Morrison set up a committee of women Members of Parliament under the chairmanship of Miss Megan Lloyd George to help him with advice on salvage matters. The first recommendation of this committee, it is announced, which has been adopted by the Minister, is to apply the principle of compulsion to the collection of salvage. Under the powers conferred upon him by the Defence Regulations, Mr. Morrison will shortly issue directions to all local authorities, representing populations of over 10,000, requiring them to provide or to maintain schemes to deal efficiently with the collection and disposal of the materials most urgently required. It is further proposed to follow these directions with an order requiring householders to make these materials available for collection. Details of methods of collection, which will be as simple as possible, will be made known to each district. While the responsibility for seeing that the collection of salvage is properly organised will rest with the local Councils, provision is also to be made for utilising merchants and voluntary organisations who have already given important help. By this means the machinery of collection will be fully used and overlapping should be reduced, with saving in man power, petrol, and expenses, and increase in efficiency. When, six months ago, the Ministry of Supply requested the local authorities to extend their refuse schemes, there was a good response and continuous improvement has marked the progress of the campaign. In a recent written answer the Parliamentary Secretary to the Ministry of Supply, Mr. Harold Macmillan, gave the following figures for the month of May. In that month the value of the sales of salved materials other than that collected by merchants or voluntary organisations was £9951 in the metropolitan boroughs with a total population of 4,129,651. In March the total value was £4733 and in April £8617. In Glasgow, Birmingham, Liverpool, Manchester, Sheffield, Leeds, Edinburgh, and Bristol with a total population of 5,666,900 the amount was £32,380. The corresponding totals for previous months were March £18,706 and April £22,386.

The Control of Imports

ON Tuesday, June 25th, a statement was issued by the Board of Trade urging all Government contractors and sub-contractors to avoid all unnecessary imports, and at the same time to assist in speeding up the delivery of all imports essential for the completion of urgent war contracts. Any delay in the delivery of essential imports, the Board states, is being caused by the failure of contractors to comply promptly and fully with the import licensing requirements. Such delay, the Board says, can be remedied by applying for import licences well in advance, and not when goods have arrived at the ports; and by sending with the applications for licences evidence that the goods are essential for a specified Government contract and cannot be bought in this country. Nothing which can be bought at home, it is stated, should be ordered from abroad. The need for the avoiding of any unnecessary importing of goods is, it is pointed out, greater to-day than ever before, because every foot of shipping space and every penny of foreign exchange are required for the immediate war effort.

Shipbuilding Efficiency

IN the course of a speech made at the recent annual meeting of the Burntisland Shipbuilding Company, Ltd., Mr. Wilfred Ayre, the chairman of the company, said that the shipyard was fully employed, and output was being maintained at a high rate. He paid a tribute to the businesslike efficiency with which the Merchant Shipbuilding Department of the Admiralty was being conducted. Under the inspiring lead of the Controller and Director, it had shown, Mr. Ayre said, the facility of commanding successive waves of driving force for expedited production, while at the same time sweeping away any remaining vestiges of red tape, which tend to cling to any Government institution. At the commencement of the war the shipbuilding industry, in the desire to prevent, as far as possible, any rise in price inconsistent with actual fluctuation in costs of the important constituents involved in the industry, immediately took steps to formulate a scheme of price regulation which had for its object the anchoring of contract prices to one or other of the principal commodities employed in ship construction. The governmental control of steel prices, together with the national wages rates throughout the shipbuilding industry, fortunately enabled such a scheme to be made possible, and, in fact, it had been adopted by practically all shipbuilders and marine engine builders. All contracts for new ships which the firm had made since the beginning of the war were on that basis. The scheme was one which, besides ensuring a fair and reasonable price to the shipbuilder, provided the shipowner with proper safeguards which are denied by certain other alternative contractual arrangements for taking account of the many changes in cost of construction liable to occur in war-time conditions. In a speech broadcast on Saturday evening, Mr. Ernest Bevin, the Minister of Labour and National Service, referred to shipyard workers. He said that every man in the shipyard, whether he were working on a naval or a merchant ship, was responsible for the effective maintenance of the Fleet. His duty when a ship had been knocked about, or a new one was being built, was to put it into service at the earliest possible moment. That applied also to the men and women working on marine engineering, gun mountings, electrical apparatus, and everything else that was needed. Every ship we could get in the water now was a contribution to winning this victory, and men in the shipyards and in the factories had as large a responsibility as if actually enlisted.

The Late Professor Alfred Fowler

BY the death of Professor Alfred Fowler, which occurred at his home at Ealing on Monday, June 24th, at the age of seventy-two, the British scientific world has lost a distinguished worker. He was Emeritus Professor of Astro-Physics at the Imperial College, South Kensington, and was a Past-President of the Royal Astronomical Society. Professor Fowler's principal work was connected with spectra analysis. He began his career by gaining a scholarship in 1882 at the Imperial College, then the Normal College of Science at South Kensington, and began work in the laboratories. In 1886 he became a demonstrator, and among his pupils were Sir Richard Gregory and Mr. H. G. Wells. His scientific work soon claimed attention, and in 1893 he was chosen to be a member of the British Government Eclipse Expedition, and was a member of five later expeditions. From 1923 to 1934 he was first Yarrow Research Professor of the Royal Society. He was also a member of the Advisory Council of the Department of Scientific and Industrial Research. In 1913 he was awarded the Valz Prize by the Paris Academy of Sciences for his work in spectroscopy. During the years from 1914 until 1924 he was the Bakerian Lecturer of the Royal Society. In 1915 he was awarded the Gold Medal of the Royal Astronomical Society, and three years later he received the Royal Medal of the Royal Society. Other awards included the Henry Draper Gold Medal of the National Academy of Sciences at Washington, presented to him in 1920, and the Catherine Wolfe Bruce Gold Medal of the Astronomical Society of the Pacific, which he received in 1934. He was an honorary Doctor of Science of the Universities of Bristol, Durham, and Leeds, and an honorary Sc.D. of the University of Cambridge. For many years he was corresponding member of the Academy of Sciences, Paris, and of the Instituto de Coimbra of Portugal. He was elected a Fellow of the Royal Society in 1910, and was made a C.B.E. on his retirement in 1935. From 1935 to 1937 he was President of the Institute of Physics, and his address to the Mathematical and Physical Section of the British Association in 1926, of which he was President, on the progress made in the analysis of spectra, will long be remembered.

Restriction on Engagement Order

A SUMMARY of the provisions of the Restriction on Engagement Order, which was made by Mr. Ernest Bevin, the Minister of Labour and National Service, and came into force on Monday, June 10th, was given in a Journal note on Friday, June 14th. The Order has raised many questions as to the scope of the provisions with regard to workers in professional, technical, or other grades above that of an operative in the general engineering and civil engineering contracting industries and the building trades. Inquiries have been made as to the effect of the Order on employers and workers, and newspapers in the matter of advertisements for such workers. Notes issued by the Ministry for guidance point out that restriction of engagement in the industries above named imposed by the Order applies only when an employer in one of these three industries engages or seeks to engage a worker for work in his undertaking. It does not therefore affect the engagement of staff by professional firms, such as architects or quantity surveyors, who are not themselves engaged in one of these three industries as defined in the Order. Also it does not affect the engagement of a person of the type usually employed in one of the industries by an employer not engaged in one of the industries. Attention is called to the very wide definition of the general engineering industry for the purpose of the Order, which includes all operations involving the manufacture, assembly, or repair of metal articles, involving the use of machine tools, whether or not such work is the principal work of the firm. Thus the maintenance department of a textile firm would come within the definition of the engineering industry. Classes of employment to which the Order does not apply include managers, salesmen, or clerks (other than costing clerks, progress clerks, and draughtsmen), and persons engaged for domestic service. In these cases there is no restriction on the method by which the workers are to be engaged. It is further pointed out that the term " manager " is not confined to persons who are actually called managers in the course of their duties. A manager is a salaried official in executive charge of a department, works, contract, or office, and the term can be held to include superintendents or head foremen in charge of other foremen, but it does not include foremen, chargemen or anyone in receipt of hourly rates of pay or piece workers. The engagement of professional and technical workers is covered by the Order, and the mere fact that a worker has professional status or is a salaried employee does not exclude him from the operation of the Order, unless his functions come within those of a manager, as explained above. In cases of doubt as to the scope of the industries reference should be made to the terms of the Undertakings (Restriction on Engagement) Order, 1940, Statutory Rules and Orders, 1940, No. 877, which is to be obtained from the Stationery Office or through any bookseller.

New Tank Board Appointments

THE Minister of Supply, Mr. Herbert Morrison, in consultation with the Secretary of State for War, Mr. Anthony Eden, has now announced the appointment to the Tank Board of representatives of the War Office and the Ministry of Supply. The War Office representatives on the newly constituted Tank Board are Major-General Pope and Brigadier D. H. Pratt. The Ministry of Supply will be represented by Captain G. D. Burton, the newly appointed Director-General of Tanks and Transport, whose appointment in succession to Mr. Peter F. Bennett was referred to in one of last week's Journal notes. There will also be a second representative of the Ministry of Supply, according to the subject under consideration by the Board. It may be recalled that the constitution of the new Tank Board was announced in the House of Commons on May 29th by Mr. Herbert Morrison, and was recorded in our Journal of June 7th. The Chairman of the Board is Sir Alexander Roger, who is chairman of British Insulated Cables, and a former chairman of the Birmingham Small Arms Company, while other members are Mr. A. A. M. Durrant, Chief Engineer of the Buses and Coaches Department of the London Passenger Transport Board; Mr. H. J. S. Moyses, the managing director of the Birmingham Railway Carriage and Wagon Company, Ltd.; and Mr. D. W. Thompson, a member of the General Council of the Trades Union Congress.

Crystal Palace Water Towers

AT a recent meeting of the trustees of the Crystal Palace it was decided that in view of the need for cast iron the time had arrived for the demolition of the two water towers which survived the fire of November 30th, 1936. The work of demolition has been entrusted to George Cohen, Sons and Co., Ltd., of 600, Commercial Road, London, E., and is to be put in hand forthwith. The towers were designed by Isambard Kingdom Brunel, when the Crystal Palace was moved to Sydenham, and were erected between 1853 and 1856, in which year the fountains they served were put into use. Writing in the second volume of THE ENGINEER, of July 4th, 1856, we said that these towers were among the most interesting engineering works of that day. Some idea of their strength and magnitude, we remarked, could be formed from the fact that each tower had to support at a height of nearly 300ft. from the ground a body of water of not less than 2000 tons in weight. They are polygonal in construction, with a diameter of 46ft. from centre to centre of the columns. A series of cast iron columns and girders is employed, the whole of the height being divided into tiers or galleries, which are reached by an internal winding staircase. In one of the towers a lift was installed at a later date. The total height from the first floor or tier to the top of the chimney cap is, we recorded, 279ft. With a full water tank the total weight resting on the foundation of the tower is:—Water in tank, 2000 tons; wrought iron in tower, 240 tons; cast iron in tower, 638 tons; glass, timber, lead, &c., 200 tons; giving a total weight for each tower of 3078 tons.

The Mono Basin Project

No. II

(*Continued from page 549, June 21st*)

HEADING No. 1, inward from the west portal, and heading No. 2 from shaft No. 1 did not meet until August 21st, 1938, and holing-through took place at a point 22,426ft. east from the west portal and 2036ft. west from shaft No. 1. Of the section of tunnel so driven 45 per cent. required timbering to provide necessary support for the rock before the placing of the concrete lining. The tunnel has a horseshoe-shaped cross-section, and is 9ft. high and 9ft. 7·5in. wide after lining.

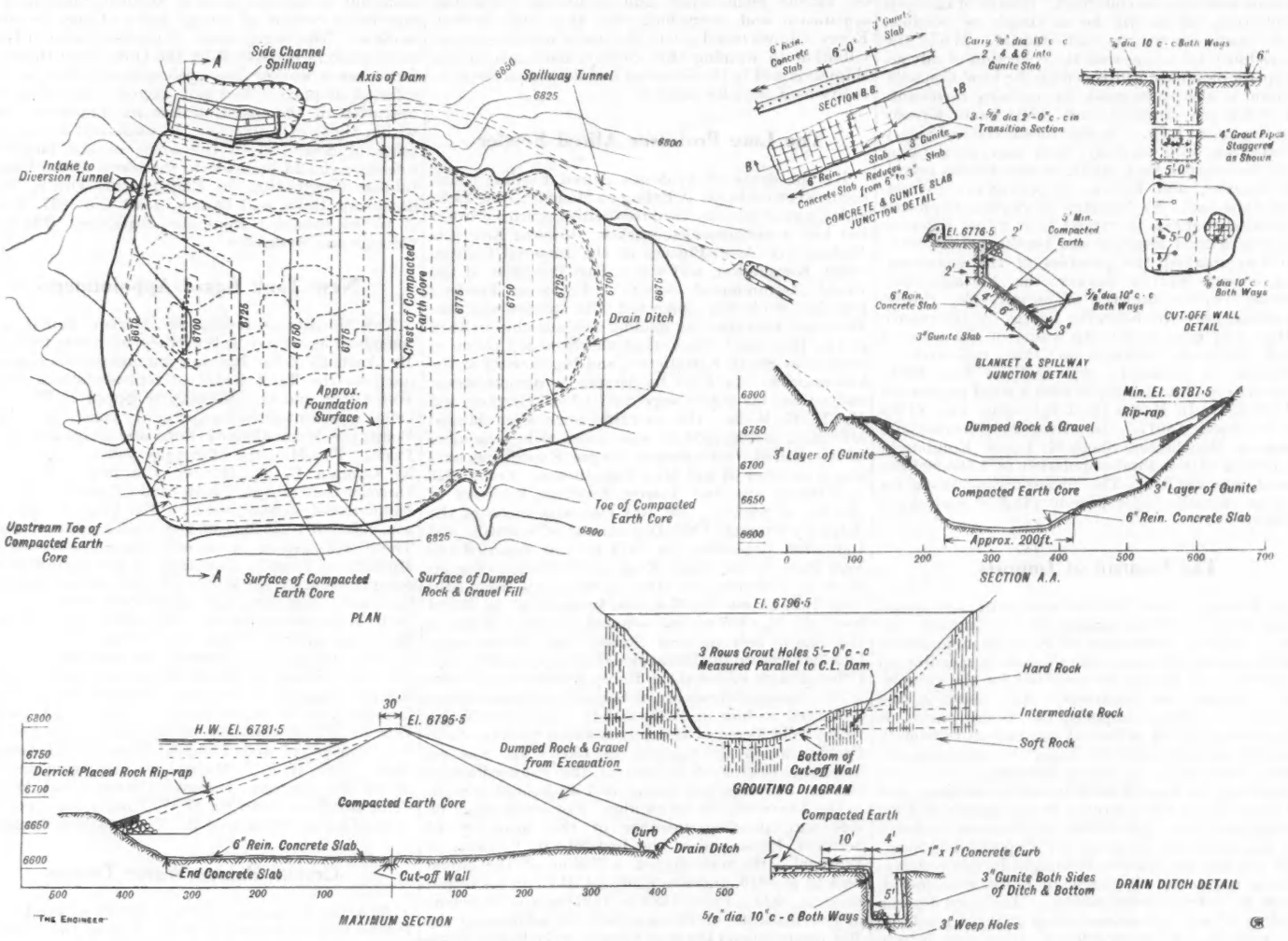
On page 572 we reproduce some views illustrating this article.

Notwithstanding the broken condition of the rock, principally rhyolite, encountered as heading No. 1 was driven and the increasing volume of inflowing water after a penetration of 5000ft., the situation became serious only when the heading was advanced something more than 2 miles from the west portal. Then the incoming water, under considerable pressure, carried with it large quantities of carbon-dioxide gas in solution, and the gas was immediately released from the water on reaching the atmospheric pressure prevailing in the tunnel. The problem was how to control the diffusion of the gas in order to maintain it at 2 per cent. or less within the tunnel so that the workmen would not be endangered. The protective measures had to be such as would meet varying volumes of CO_2. The primary answer was improved ventilation; and the most practical way to achieve that end was to transform test hole 3–J into a ventilating shaft of suitable size. Subsequently, that hole when enlarged became known as shaft No. 3. When that expedient was resorted to the test hole met the tunnel line 2574ft. rearward of the working face of heading No. 1. From that position it was found practicable to enlarge the hole into a 535ft. shaft by sinking operations from the ground surface and raising operations from the tunnel itself, carried on simultaneously. The work involved was completed within a span of six weeks. The shaft was equipped with two compartments: one a hoistway and the other a manway. Blower equipment was placed just below the bottom of the shaft, and thus fresh air could be drawn down into the tunnel easily and much more quickly than through the ventilating ducts reaching back to the west portal, more than 2 miles distant. The arrangement also obviated running more ducts through the tunnel and thereby causing objectionable crowding. The blower capacity at shaft No. 3 was slightly in excess of 30,000 cubic feet per minute. The units were capable either of drawing air down through the shaft or of discharging upward through it to the surface.

The next phase of the problem was to devise means to intercept the gas-bearing water entering the tunnel, to control the gas thereafter while within the tunnel, and finally to carry it out of the tunnel and discharge it clear of the west portal. Throughout the gaseous section of the tunnel, and conforming to the sides and arch, the excavation was paralleled with special metal sheathing, and at each end of the sheathing the space between the rock and the sheathing was sealed with gunite. The tunnel invert along the bottom edges of the sheathing was sealed with a flooring of 2in. planking, on which the rails for the muck trains were laid; and in the centre of the invert, to a depth of 2·5ft., a ditch was cut to function as a gas sump—the heavy gas naturally settling to the low point so offered. The floor was supported on heavy transverse timbers spaced 3ft. apart on centres. An exhaust pipe, connected with a blower plant just outside the west portal, was laid with its intake within the sump; and, with the blowers in action, a negative pressure was induced that promoted the downward and outward movement of the CO_2 issuing from the rock walls. The withdrawn gas was discharged into the free air at a point well outside the tunnel. By blowing about 24,000 cubic feet per minute of fresh air into the tunnel, drawn from shaft No. 3, it was found practicable to keep the CO_2 content near the heading well within the prescribed maximum limit of 2 per cent. It is said that the workmen were not affected in their respiration noticeably unless the carbon dioxide content was in excess of 2·5 per cent.

To guard against further tapping of gas-bearing areas, exploratory drilling was adopted. Test holes were driven in advance of heading No. 1 to depths of from 11ft. to 40ft. The holes radiated from the heading, and if gas were encountered grout was promptly forced into them. For this work a grouting machine capable of developing a pressure of 700 lb. per square inch was used. The grouting also served to seal water-bearing rock. The volume of carbon dioxide entering the tunnel fluctuated, the inflow being influenced more by the rate of change in barometric pressure than by the magnitude of that pressure, *per se*. It is reported that the movement of the CO_2 into the tunnel averaged 1000 cubic feet per minute when the heading penetrated to about the centre of the craters, and the maximum quantity was approximately 1400 cubic feet per minute.

After headings Nos. 1 and 2 met in August, 1938, the stretch of tunnel between shaft No. 1



PLAN, SECTIONS AND DETAILS OF THE LONG VALLEY DAM

the west portal and from shaft No. 1 toward shaft No. 3 could, by changing the size of the openings in the two gates of the airlock, be regulated to meet varying conditions.

Water was encountered after heading No. 1 had been advanced more than a mile and from then onward the inflow increased until it exceeded 9000 gallons per minute at the time of holing through with heading No. 1. The incoming water was handled by pumps that discharged through three 14in. lines—two extending to the west portal and one leading up through shaft No. 3. In addition to the pick-up pumps placed along the line where water was entering in outstanding quantities, there were booster pumps at four points in the tunnel west of shaft No. 1. Each of the 4500-gallon per minute units was capable of working against a 210ft. head and could be operated by remote control from shaft No. 3. Two 6000-gallon per minute units at shaft No. 3 pumped directly from a sump into which any or all three of the 14in. lines could discharge.

As a precaution against the possible flooding of shaft No. 1 by an inflow of water into the tunnel exceeding the installed pumping capacity, reinforced concrete bulkheads, with heavy steel doors, were constructed at headings Nos. 2 and 3 in the tunnel, respectively west and east of the shaft. These bulkheads were strong enough to withstand a hydrostatic head of 350ft. on their outer sides remote from the shaft. Water pipes, ventilation ducts, and other essential conduits passed through the bulkheads. The doorways afforded a clear passage 5ft. wide and 7ft. high. A 20in. pipe that pierced each bulkhead could be used as an emergency manway.

In driving the tunnel a drill carriage was used at each heading for drilling a round consisting of from 24 to 40 holes—the number depending upon the nature of the rock. The average advance at a round was 5ft., but in sound rock the advance at a round varied from 6ft. to 7ft. Each drill carriage was a two-deck structure consisting of a framework of 4½in. pipe mounted on trucks having a 24in. gauge. The forward truck of each carriage had four wheels because it supported the greater part of the weight, and the frame was attached to it by a king-bolt. The rear of the carriage rested on a truck with a single pair of wheels. The four horizontal pipe members of the framework projected forward to provide cantilevered supports for the mountings of four drifter drills using hollow round steels of 1¼in. section and ranging in length from 4ft. to 32ft. The drill mountings permitted the drills to be moved through vertical or horizontal arcs.

The character of the ground pierced by the tunnel has necessitated the very extensive use of support for the rock in advance of lining. Near the two portals, tunnel sets of 8in. by 8in. timber were satisfactory, but elsewhere steel I-beam and H-beam sets were required. In some areas of very heavy ground the sets were supplemented by steel spreaders placed across the invert to prevent the deformation or displacement of the tunnel sets. Usually the sets were arranged 5ft. apart, but at numerous places the sets were separated only by a few inches. In soft ground timber spiling had frequently to be driven in advance of the tunnel sets close to the drill face.

The lining of the tunnel was intermittently carried forward following the earlier stages of driving. In connection with the lining operations, much trouble was experienced in keeping inflowing water under control during the work. Generally speaking control was effected by laying one or more 5in. perforated sheet-metal pipes in a subgrade trench which was afterwards backfilled with gravel. The drains carried the water to pump sumps which were partly outside the tunnel section. This plan permitted the forms for the tunnel lining to be placed within the tunnel section and left the drains open to service even after the invert was poured. Wherever excessive water entered from the tunnel roof it was intercepted by sheet metal secured to the tunnel sets so as to divert the flow to the sides of the excavation and down to lateral drains which, in turn, connected with the longitudinal drains in the subgrade.

Steel forms were used for the inner side of the curb of the floor of the invert lining. The steel forms for the side walls and arch sections were assembled in 30ft. lengths on carriages and were elevated into position, and afterwards lowered by means of hydraulic jacks. A Ransome concrete gun, of 1-yard capacity, mounted on trucks and attached to the concrete-mixer carriage, placed the concrete through a 6in. flexible discharge pipe. The tunnel lining was placed at the rate of from 200 to 300 linear feet in the course of a day of three working shifts, and it is reported that the lining has averaged about 2 cubic yards of concrete for each linear foot of tunnel.

From the east portal of Mono Craters tunnel the water will be discharged into Deadman Creek, by which it will reach the Owens River and continue southward for something less than 15 miles until it enters the Long Valley reservoir. That reservoir is to provide storage for 163,000 acre-feet of water, received from both the Mono Basin and the Owens River; and the high-water elevation of the reservoir will be at 6781·5ft. above sea level. Between the Long Valley reservoir and the power plants along the Los Angeles aqueduct there will be a drop in the gravity flow of approximately 4000ft, which can be effectively utilised in generating electric energy—particularly so when a projected power plant is built at the Owens River gorge. When that is done, each cusec of water delivered from Mono Basin will generate about 1,000,000 kWh annually, and this would beadditional to the similar use of water made available from the Owens River itself. Further, each cusec of water from the Mono Basin, passing through power plants now in existence on the Los Angeles aqueduct, will generate approximately 895,000 kWh annually; and, finally, each cusec of water so used from the same source at the Haiwee power plant will generate 93,500 kWh annually. In addition to yielding a large block of electric energy, water from the Mono Basin will reduce proportionately the need for pumping water from the deep wells in the Owens Valley, where the continued drain over years of reduced rainfall has steadily lowered the level of the ground water and increased the cost of lifting and delivering the water to the Los Angeles aqueduct.

Work on the Long Valley dam, which was started in the summer of 1935, but halted at the close of 1936, was resumed in April of 1939, under a contract that called for the completion of the dam within a period of 450 working days. The dam is of the rockfill, compacted-earth-core type. From base to crest the structure will have a maximum height of 182ft.; its crest, which will have a length of 550ft., will provide a freeboard of 15ft. above the side channel spillway. The crest will carry a roadway 30ft. wide. The dam will contain about 1,000,000 cubic yards of fill, including 225,000 cubic yards of fill on the slopes.

The project necessitated the advance construction of four permanent camps along the tunnel line, each capable of housing about 200 men. All the camps are lighted by electricity, and all the kitchens are electrically equipped. Butane gas has been used as the fuel for heating purposes. A water-supply was created for camp and construction uses; and a 33-kV power transmission line was run to the several camps and to the construction points. Telephone lines connect all parts of the undertaking and are hooked up by telephone and teletype with the main office in Los Angeles. Because of the heavy snowfalls and the deep drifts, snow sheds were constructed at each end of the Mono Craters tunnel to assure access to the tunnel and to permit work to be carried on without interruption. Miles of roads had to be built both in and without the basin to facilitate transporting men, materials and supplies.

Virtually all work, with the exception of some trucking contracts and the contract for the concluding construction of the Long Valley dam, has been done by the City's forces under the direction of the Department of Water and Power and the Bureau of Water Works and Supply, of Los Angeles, of which Mr. H. A. Van Norman is chief engineer and general manager. Mr. H. L. Jacques is in charge of the construction of the project, with Mr. W. W. Wyckoff as engineer, and Mr. R. R. Proctor as field engineer.

Switchgear Contacts

By G. WINDRED

No. II

(*Continued from page 559, June 21st*)

Arcing Contacts

MANY types of circuit-breaker are provided with auxiliary contacts, the function of which is to close before and open after the main contacts, and thus to relieve them from the effects of arcing. An important consideration arises in connection with the opening process in a switch having this type of contact, since with given conditions it is possible for an arc to occur when the main contact opens, and before the arcing contact breaks the circuit. From Fig. 2 it will be seen that when both contacts are closed, as at A, the main current I divides into two components, I_1 and I_2, flowing

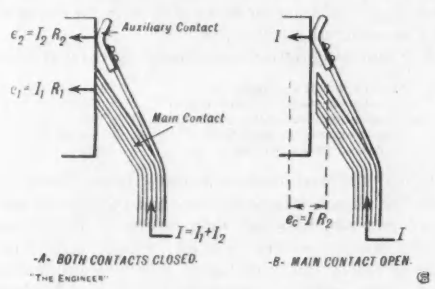


FIG. 2

through the main and auxiliary contacts respectively. The values of these component currents will be inversely proportional to the respective contact resistances, if the resistances of the contact parts themselves are neglected. When the main contact has just parted from the fixed contact, as shown at B in Fig. 2, the voltage across the gap will be equal to the voltage drop across the auxiliary contact. Unless the auxiliary contact resistance changes owing to the larger current shunted through it by the opening of the main contact, this voltage drop will be given by $e_c=IR_2$, and if this exceeds the arcing voltage for the particular contact metals, the breaking of the main contact will result in an arc.

According to reliable determinations, the minimum arcing voltage for most contact metals lies between about 12 and 16 volts. From these figures it will be seen that when breaking a current of 1000 amperes, for example, an auxiliary contact resistance of more than 0·010 ohm introduces the risk of arcing at the main contact. It may be pointed out that although the striking of this arc reduces the current flowing through the auxiliary contact, the corresponding reduction of e_c may not be sufficient to cause extinction of the arc. Risk of main contact arcing is naturally increased under short-circuit conditions.

These considerations emphasise the necessity for care in the selection of auxiliary contact materials and the application of adequate pressure to ensure low contact resistance. It is evident that this important factor must receive consideration along with such properties as hardness and resistance to the effects of arcing. In cases where very heavy currents are handled, the use of a supplementary contact intermediate between the main and arcing contacts may be found necessary.

Contact Materials

It would be difficult to overestimate the importance of contact materials in the design of switchgear, and yet the selection of materials in practice is still largely an empirical matter. Modern research has done much to put the subject on a more logical basis, but a vast amount of work in this direction still remains to be done. It may be useful to review the subject here briefly under headings representing the different classes of materials used for contact purposes.

Metals.—A wide range of individual metals is available for contact purposes, but only copper and silver have found any extensive application in ordinary switchgear practice. The introduction of silver is a comparatively recent development, due mainly to the harmless nature of the surface films which form on this metal in comparison with those associated with copper. During recent years the use of silver has extended to the main contacts

of quite large circuit breakers, and in cases where adequate auxiliary contact protection is provided there is no doubt that silver has provided a solution to the problems occasioned by the tendency of copper to produce a high resistance oxide film at moderate temperatures. The use of silver contacts is now so extensive that further comment here is unnecessary.

Alloys.—Although there is ample scope for further investigation, there is no lack of evidence that alloys present many advantages for contacts. This will be readily appreciated in view of the fact that it is possible to accentuate any property of a given metal by alloying it with another. This procedure has permitted the development of contact alloys having definite advantages over pure metals with respect to such properties as hardness, wear resistance, and high melting point.

It is well known that the physical properties of alloys are sometimes profoundly affected by relatively small changes of composition, and that equally important effects may be produced by the forms of hot or cold working to which the finished material may be subjected. It is consequently necessary that these factors shall be carefully controlled if uniformity of production is to be obtained. The necessary control is sometimes difficult to apply, and the whole subject of uniformity is an important one for the metallurgist.

In view of the extensive application of copper as a contact material it is natural that many attempts have been made to overcome its disadvantages by alloying with other metals. The chief drawback has been that the improvement of mechanical properties in this way is accompanied by reduction of the electrical conductivity. The thermal conductivity is generally reduced in the same way. There is also the question of increased cost, depending upon the particular alloying metal.

During recent years the technique of producing copper alloys for electrical purposes has developed rapidly, and the loss of conductivity caused by the introduction of such metals as aluminium, nickel, tin, and zinc has been overcome to a large extent. This improvement has been obtained by a modified method of improving the mechanical properties by alloying. Minute particles of rarer elements are dispersed throughout the material by means of special heat treatment, and result in marked improvement in the mechanical properties with very little reduction in electrical conductivity. The mechanical properties are also retained at temperatures far in excess of the softening point of copper.

The necessity for hard conducting materials with high impact strength and wear resisting qualities has arisen in connection with welding electrodes, and for this application a number of copper-base alloys have been developed. It will be realised that these alloys are not always applicable for ordinary contact purposes, since conductivities and contact resistances which are satisfactory for welding may be unsuitable for switch contacts. In cases where hardness and wear-resistance are of greater importance than low contact resistance, as in the case of collector shoes carrying heavy currents where surface films are unable to form under working conditions, the hard but electrically inferior copper alloys are to be preferred. For such applications their use has been very extensive.

SINTERED MATERIALS

Some metals do not combine with others to form alloys in the true metallurgical sense, but can be made to form solid mixtures in which the individual properties of the respective component materials are more or less preserved. The technique of production of these mixtures represents a development of powder metallurgy. During recent years there has been considerable activity in the development of sintered materials for contact purposes, owing to their characteristics of great hardness and high melting point, which are of evident value in many cases. At the present stage of development it is not possible to assess accurately the comparative usefulness of sintered materials, since they have not yet found extensive application, but it is evident that in cases where high melting point and great hardness are required, they offer definite advantages.†

The metals generally employed are tungsten or molybdenum or their carbides with either copper or silver; the underlying idea being to obtain a product having the desirable qualities of each material without its disadvantages. Thus the hardness and wear resistance of tungsten might be combined with the high electrical conductivity of copper or silver so as to produce a material with intermediate qualities, harder than copper or silver but having better electrical conductivity than tungsten or molybdenum, and being less prone to the formation of surface films. The latter property would naturally be expected in the case of additions of silver rather than copper. This desirable combination of properties appears to have been obtained to a marked extent, and several of the compounds warrant consideration as contact materials.

There are two principal methods by which the tungsten-copper mixture may be prepared. In one method the respective metal powders are mixed together and then sintered in a hydrogen atmosphere. The molten copper wets the tungsten particles and binds them together; the hydrogen acting as a flux. In the other method the sintered tungsten is heated with molten copper in hydrogen. This process causes absorption of the copper into the tungsten structure by capillary action.

With reference to contact applications, it may be said in general that mixtures with a low copper content are applicable chiefly in cases where the contacts must withstand the pitting and burning associated with the interruption of high currents. A typical application is represented by the arcing contacts of circuit breakers. The low-copper mixture also withstands hard wearing conditions. Mixtures containing as much or more copper than tungsten are used for oil-immersed contacts and for sliding contacts of the kind used in drum controllers, where the high contact pressure prevents the accumulation of surface films. Experiments described by K. Méier‡ indicate that tungsten-copper containing 60 per cent. tungsten used for oil-switch contacts had a life about six times as long as that of corresponding copper contacts.

Owing to the difficulty of working materials in which an appreciable amount of tungsten is present it is usual to apply them in the form of a facing on a suitable supporting member, generally of copper. The facing may be attached by brazing, riveting, or welding, or the supporting member may be cast into a suitable cavity in the contact. In all cases where heat is applied it is necessary to employ a hydrogen atmosphere so as to prevent oxidation. The making of satisfactory joints is a specialised procedure, requiring particular care and experience.

The following properties apply to a tungsten-copper product of typical constitution:

Specific weight, g/cm³	13·2
Specific resistance, microhms/cm³ ...	5·1
Thermal conductivity, cals/cm./sec./°C.	0·36
Linear expansion coefficient	11×10^{-6}
Hardness (Rockwell B)	90

The tungsten-silver mixture is available with various compositions for contact purposes, and finds its chief application in cases where freedom from poorly conducting surface films is required in combination with good mechanical properties. Typical applications are represented by air-break switchgear for medium and low voltages, and where the operation is very frequent.

Owing to its hardness, tungsten-silver is used for contact purposes in the form of facings, in the same way as with tungsten-copper.

The following figures apply to a typical material:

Specific weight, g/cm³	15
Specific resistance, microhms/cm.³ ...	3·9
Thermal conductivity, cals/cm./sec./°C.	0·44
Linear expansion coefficient	8×10^{-6}
Hardness (Rockwell B)	95

Other sintered materials have been developed with the object of overcoming the excessive erosion and wear which occur with ordinary metals and alloys under severe service conditions. They include silver-molybdenum, silver-molybdenum-lead oxide, silver-tungsten-lead oxide and silver-tungsten carbide. These new materials are claimed to have considerable resistance to arcing as well as to mechanical wear, and may be expected to assist still further in the progress of switchgear development.

LUBRICATION CHART.—We have received from David Brown Tractors, Ltd., Meltham, a copy of a lubrication chart for the David Brown tractor, which, besides indicating by numerals on a diagram the whereabouts of the various points, is also illustrated by half-tone engravings showing the appearance and exact location of the points. The chart includes instructions regarding periods at which the points should be attended to.

† L. B. Hunt, "Heavy Duty Contacts," *Electrical Review*, March 31st, 1939, p. 459. L. B. Hunt, "Contact Problems in Switchgear," *Electrical Industries*, March, 1940, p. 82.

‡ K. Méier, "Schaltstücke mit Sondermetallauflage für Olchütze," E.T.Z., 57, 1936, page 493.

The Salvage of H.M.S. "Thetis"*

By G. R. CRITCHLEY

(*Continued from page 561*)

A CONFERENCE was called by the Controller of the Navy to be held on July 27th, and at that conference it was agreed that operations should be continued with the proposed steel girders.

The author's view was, however, that it was unfair, and somewhat unreasonable, to expect Dr. Robb to perform single-handed the technical investigation and calculation which we were demanding in as many hours as would normally take days, and that it was imprudent to leave the entire onus of calculations upon one man, however eminent, having regard to the importance which was being attached to the case, and therefore a request was made to the Controller of the Navy at the conference for the Director of Naval Construction to be associated with Dr. Robb in this matter. A further request was made that as the conditions experienced at the case had considerably perturbed our chief salvage officer, who successfully lifted five submarines in the last war, and is probably unique in the matter of general salvage experience under open sea conditions, as well as his immediate junior, who had successfully raised one submarine in the last war and has been responsible for numerous lifting and general salvage operations during the past twenty years, the Admiralty should place at the disposal of the case a mooring vessel which could assist "Ranger" in raising and re-laying all the heavy ground moorings to keep pace with "Zelo" carrying the submarine inshore, the apprehensions of our officers being that as there had been no period of settled weather, and there was no immediate sign of any settled weather, "Zelo" might be caught in an intermediate position by a gale without the full system of heavy ground moorings in position, and if the lifting wires had to be slipped the strong tidal currents would produce such an entanglement about the submarine that many weeks of laborious work would be necessary to recover them, and autumn was quickly approaching.

Both these requests were granted by the Controller of the Navy.

In the course of a few days a design of steel beams with built-in bollards on lines we had indicated was produced, but the time for construction and fitting was estimated at six weeks. As that would have meant that operations would not have been resumed until the middle of September, representations were made for a simplification of the design so as to reduce the time of construction, and detailed amendments were made, but Messrs. Cammell Laird and Co.'s yard was to be closed from August 5th to 12th, which threatened to involve a week's delay. However, after a personal appeal to the managing director of Cammell Laird and Co., holiday leave for the men required for the work was suspended, and by continuous day and night work, "Zelo" was refitted and again proceeded to the case on the morning of August 24th, which was a magnificent performance by Cammell Laird and Co., and in the result the saving of time was probably vital to the success of the operations, because, in fact, lifting operations were completed by September 3rd. and the weather broke on September 10th.

Fig. 6 is a diagram of the steel beams with built-in bollards and a cast steel bolster at each end of each beam constructed with leads to the bollards to take the load over the deck edges of the lifting craft. It was decided to revert to the principle that the bollards should be capable of withstanding a load greater than the breaking load of the 9in. wires, and that their incorporation in the lifting beams should be arranged so as to leave adequate working space in the centre of the deck. The pins of the bollards were constructed from 1¼in. plates, and plates of this thickness rolled to an outside diameter of 36in. would be subject to a stress of rather more than 3 tons per square inch under the combination of the calculated bending and twisting moments of 2715 inch-tons and 3413 inch-tons respectively.

The requirement that the bollards should be incorporated in the beams suggested the provision of a bottom plate as well as a normal base-plate, the distance between the two being the depth of the lifting beam. As it was decided that 30in. would be an adequate depth for the beam, the pins of the bollards were made 5ft. long, thus leaving adequate height above the base-plate for belaying the wires. These pins were reinforced internally in order to resist the calculated crushing loads. The width of the base-plate was determined by the need for the provision of adequate scarfs for the outer webs of the cross beam, and the extensions of the base-plate at the centre line of the bollard were arranged to provide attachments for a central web of the cross beam.

A completed bollard was tested at Lloyd's proving house at Netherton to a pull of 180 tons.

There were two figures of eight on the bollard with one end of the wire secured to the standing end of the testing machine and the other end secured to the travelling end. Dr. Robb estimated that with the load of 180 tons at each end of the equivalent of a

* Institution of Naval Architects. Released forthwith for written discussion.

double tackle with excessive friction, the twisting moment on a pin would be equal to that used for design purposes, and the crushing force between the pins would be greater than that developed under the assumed conditions. There was no sign of disturbance of either riveting or welding on examination of the bollard after the test.

The beam was adequately strong to resist the bending moment imposed by the vertical loads on the wires, and the bending moments in the horizontal plane set up by the wires leading off the centre to the circumferences of the outer pins were resisted by struts fitted between the bollards and from the end

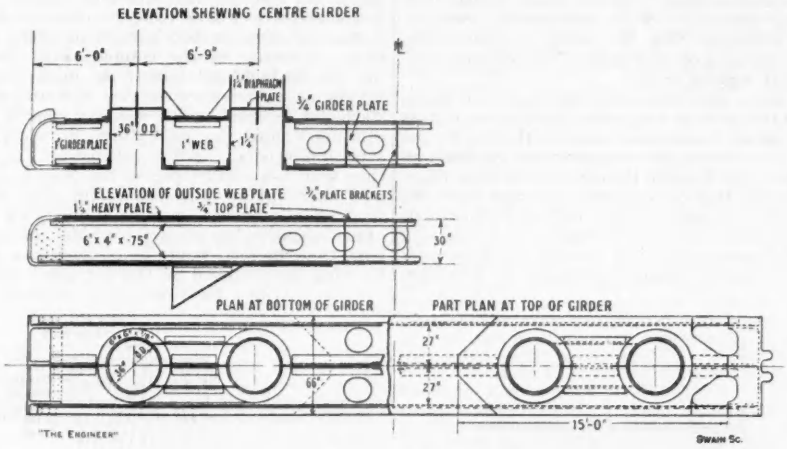


FIG. 6—*Steel Beams with Built-in Bollards*

bollards down to the deck. These struts served also as anchorages for the beams in the event of the submarine when slung touching the ground while the lifting vessel still had ahead motion, in which event there would be a tendency for the lifting beams to be dragged aft.

As a precaution against the submarine acting as an anchor while the lifting ship was being drifted to leeward, the brackets shown on the diagram were arranged below the bollards; wooden wedges being fitted between these brackets and the hatch coamings.

It had been estimated that under the original conditions the lifting ship had a fairly generous metacentric height, even with a load of about 1000 tons suspended from the beams on the upper deck. The steel beams were, however, very much heavier than the timber beams, and it was considered proper to carry out an inclining experiment shortly before the ship sailed, and this showed that with the load slung from the beams there would be a small positive metacentric height.

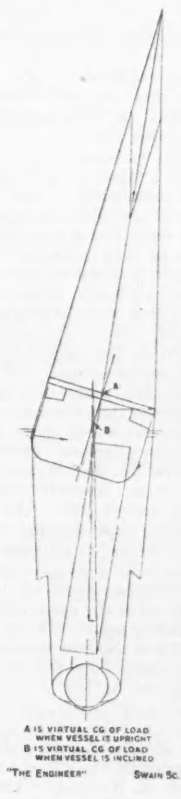


FIG. 7

Fig. 7 is a diagrammatic representation of the lifting vessel inclined at a small angle with the submarine suspended below. This shows that although at a very small angle the load would be freely suspended, and therefore act as if it were concentrated at the ends of the beams, one wire would soon be constrained at the bilge. The effect of this constraint is shown by the diagram as resulting in a lowering of the effective centre of gravity of the load. The diagram is, however, based on the assumption that the wires can render freely under the hull of the submarine. Experience in other cases indicates that rendering does not occur, and that therefore submarine and lifting ship virtually behave as a single unit, with the two portions rigidly connected. The main consideration is that both the diagram and the facts of experience show that the stability consideration does not present a serious problem; in fact, when the submarine was slung off the bottom, "Zelo" was perfectly stable.

It is appropriate to state at this point that timber baulks were fitted immediately above the turn of the bilge along each side of the lifting vessel so as to prevent indentation of the ship's side by the lifting wires in the event of the lifting vessel heeling under the load.

When "Zelo" returned to the scene of operations on August 24th weather conditions were ideal, and by August 26th she had been moored over the wreck and all ground moorings and the lifting wires Nos. 1, 2, 7, and 8, which had been left in position after the unsuccessful attempt on July 27th, were picked up.

There was still, however, the persistent trouble of wires becoming foul, owing to the tides, but by the morning of August 28th all lifting wires were in position, and "Zelo" was pinned down at low water, 6.30 a.m.

The submarine was lifted on the morning tide, and the first move inshore was successfully made. Further lifts were made on each succeeding tide until six lifts had been completed by 11.10 p.m. on August 30th, when the submarine had been carried into 78ft. at low water, and was in a position North 40 deg. East true 2 miles from Moelfre Island. In that position it was necessary to remove the forward periscope to prevent fouling of the bottom of the lifting craft, the after periscope having already been bent over to a nearly horizontal position at some earlier stage of the operations.

Thereafter two further full tidal lifts were made, and finally a half-tide lift, which carried the submarine into a position South 33 East true 8 cables from Moelfre Island, where she lay in 37ft. of water at low water. That is to say, her conning tower hatch was about 9ft. 6in. below water and her bridge casing about 3ft. 6in. below water.

Fig. 9 shows a section of an Admiralty chart on which are plotted successive positions after each lift, and the course taken. The course plotted by H.M.S. "Gleaner" is shown by parallel lines, and it will be seen that it was impossible to follow exactly the marked course because of drift caused by the tides.

After the second lift and during the second movement inshore, the submarine became pinned against a sandbank and remained for three hours, but cleared the bank with the continuing rise of tide. The situation was an anxious one, with "Zelo" broadside to the strong tide, but the tugs were able to hold on. Grounding of the submarine in the course of the movements inshore must be regarded as merely incidental to the operations. A common misconception is that a move inshore is not begun until the sunken craft has been lifted a substantial distance from the bottom, or, in other words, until a late stage of the flood tide, but, in fact, the move begins as soon as the sunken craft is off the bottom, and then takes the form of a slow creep inshore on to higher ground until, with the turn of the tide to the ebb, the sunken craft settles again on the bottom and the lifting wires slacken. If the bottom shelves very gradually a greater distance can be covered in one tide than if the bottom shelves more steeply,

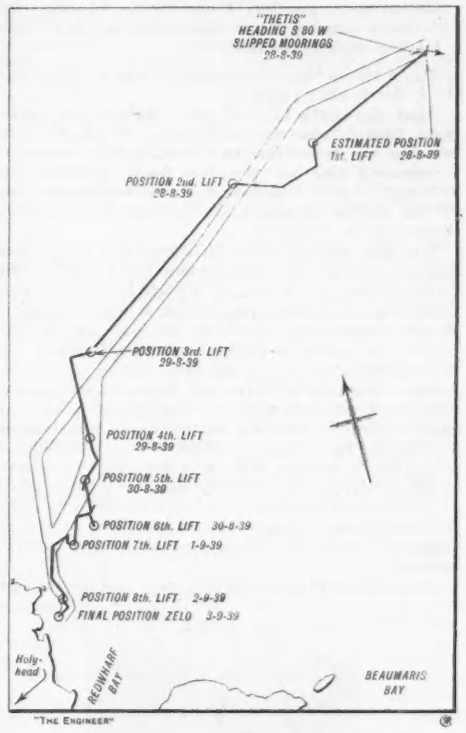


FIG. 9—*Course of the "Zelo"*

and if the bottom is irregular so that a bank must be traversed, a movement may be short whilst the bank is being negotiated, but the height of the tidal lift will be the same, and therefore a greater distance can be covered on the succeeding tide after the sunken craft has been lifted over the bank. This is well illustrated by Fig. 9, if the second movement is contrasted with the third. Slow movement inshore is dictated by the consideration that if the sunken craft encountered the bottom whilst travelling quickly the lifting wires would be broken. Applying the general principle to this particular case, the lifting craft was steered starboard bow to the tide, and the speed over the ground was kept down generally to 1 knot, but if the submarine touched bottom controllability was lost, and the lifting craft fell broadside to the tide. The two ahead tugs had then to steam up into the tide broad off the starboard bow. On the occasion to which particular reference has been made, the tugs were unable to keep position

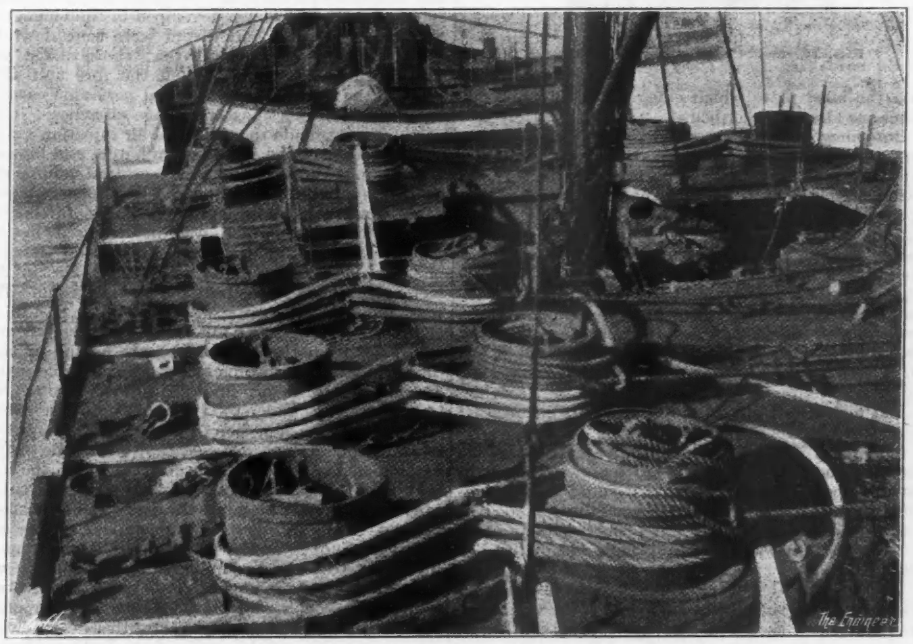


FIG. 8—*Arrangement of Wires Round Bollards After Pinning*

and fouled each other, causing some anxiety in case they should be compelled to cast off.

Although sea conditions were ideal, visibility was poor, as is indicated by the following wireless messages despatched from the scene of operations :—

7.22 a.m., August 29th : Again pinned visibility half mile, exact position unknown.

11.45 a.m., August 29th : Position still uncertain stop Have shoaled water 46ft. since original position.

3.29 a.m., August 30th : Fourth lift completed approximate position Point Lynus bearing east distance 4 miles stop Have seen no land since leaving original position.

Fig. 8 shows the arrangement of the wires around the bollards after pinning.

After the ninth lift and move inshore the operations passed into the final stage, which involved bringing the submarine to the surface by means of compressed air, but war had been declared, and although H.M.S. "Tedworth" was withdrawn, two of her divers remained at the case to assist the Association's own divers.

The plan was for divers to strongback the various hatches, except the engine-room hatch, which was removed and substituted by a plate into which were fitted one 6in. syphon pipe which would reach down to the engine-room platform and one 2in. flexible syphon pipe which could be lowered still further into a sump adjacent to the forward engine-room bulkhead. A group of three air injection valves was also fitted into this plate, as well as three other air injection valves, so that as the water was lowered throughout the submarine abaft of No. 40 bulkhead, and a larger volume of air was required to maintain a full discharge of water through the syphon pipes, this additional volume could be provided by bringing into action as required any or all three of the air injection valves to supplement the three grouped valves.

Fig. 10 shows the 6in. syphon pipe and the fitments

FIG. 10—*Steel Plate for Engine-Room Hatch*

into the steel plate which covered the engine-room hatch, as already described.

Buoyancy had to be restored to the compartments forward of No. 40 bulkhead by compressed air, injected through a valve to be fitted in the torpedo hatch, which would blow out the water through the open No. 5 torpedo tube. Nos. 2, 3, 4, 5, and 6 external tanks on the port and starboard sides of the submarine were to be controlled by compressed air injected through valves to be fitted into the tops of the respective tanks, and the No. 1 main ballast tank, which passed under the bow, was to be drained by compressed air injected through an air pipe clamped into one of the flooding holes. Each of the air injection valves was controlled by a cock operated by divers, non-return valves being useless, as they would not permit the compressed air to be released whenever this might be required.

This plan, however, although apparently straightforward on paper was so much hampered by conditions governing the work that it could not be completed until October 23rd, when the vessel was refloated and taken stern first inshore to a position where the stern was practically high and dry at low water.

Reference to the Admiralty chart which comprises Fig. 9 will show that the beach to which the submarine was carried is sheltered from prevailing south-west and west winds, and partly sheltered from north-west, but as if by malign perversity the prevailing winds did not prevail, but as from September 10th, when the weather broke, there were persistent strong northerly and north-easterly winds, accompanied by heavy swell and frequently rough seas, and, in fact, during the period of sixty-eight days whilst the vessel lay on the beach there were only twenty-one days when work was possible, and even on some of these days work was only possible for a few hours.

The report of the public tribunal has disclosed that sixty-seven of the victims of the disaster had congregated in the engine-room and thirty-two in the after crew space. It was necessary to remove the bodies from the engine-room to enable divers to obtain access to the control room and mess room, situated forward of the engine room, in order to open bulkhead doors to permit free flow of compressed air and drainage of water throughout the vessel abaft the No. 40 bulkhead, as well as to perform other necessary preparatory work by way of shutting off valves which could allow compressed air to exhaust from the vessel.

It will be a consolation to any relative of the victims who may read this paper to know that no consideration of expediting the work of salving the vessel was allowed to interfere with the removal of the bodies with the greatest possible decorum and care for their preservation, as is signified by one of the log entries : "Divers called up stop Tide too strong to deal with bodies on surface." This consideration was so strongly sustained that the work of evacuation, which commenced on September 7th, was not completed until September 30th.

When divers were eventually able to obtain access to the control room it was found that air exhausting from the diving dresses was reaching the sea surface in way of the conning tower, and it was at first presumed there was leakage through the conning tower hatch, but further investigation showed that the leakage was occurring through the forward periscope which had been broken off during the last stages of the lifting operations. This indicated leakage past the gland, and it became necessary to withdraw

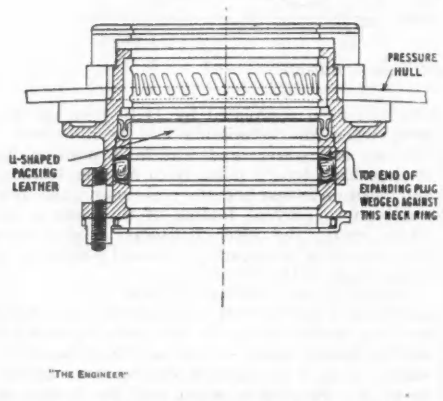


FIG. 11—*Bottom Section of Periscope Tube*

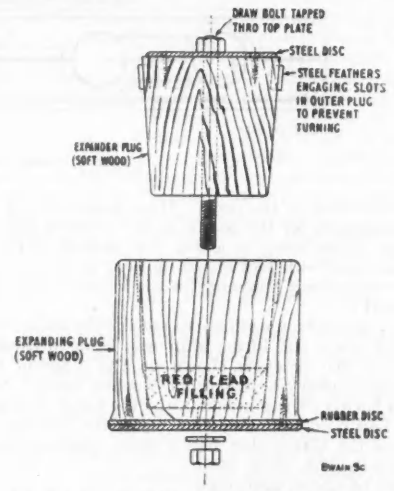


FIG. 12—*Expanding Plug for Periscope Tube*

the cross head. After this had been done and the bearing ring had been removed, a plug was inserted by divers into the forward periscope tube.

By October 11th everything was in readiness for a compressed air test of the main body of the vessel, and at 10.33 a.m. blowing was commenced, but after 30 min. a serious leakage developed in the vicinity of the conning tower, and divers were sent down to investigate. It was found that the leakage was coming through drain holes on the fore and after sides of the faucet in the forward periscope casting, but there were no signs of leakage elsewhere. Connections were made to additional air injection valves in the plate over the engine-room hatch, and blowing was resumed the next day with increased volume and the 6in. syphon pipe commenced to discharge water. After continuous blowing for six hours, further air leakage occurred, which was investigated by the divers and was found to be coming from the port main engine exhaust pipe, which was 12in. in diameter, and fitted in the port side of the casing. This was plugged and blowing was resumed at 11 a.m. on October 13th, but at about 4.40 p.m. air commenced to escape from the starboard main engine exhaust pipe and the syphon pipe stopped discharging water. The cause of the air finding its way through the engines was not understood at that time, but investigation of the construction of the engines, which were of two-stroke design, revealed that one of the pistons in each engine could be in a position where the inlet port and the exhaust port could be opened simultaneously, thus explaining the passage of the compressed air. In these circumstances it became necessary to open up the engine-room hatch to enable divers to test the group exhaust valves. It was found that the port engine group exhaust valve was half a turn open and the starboard engine group exhaust valve two turns open, and these were closed. An investigation of the cause of the leakage through the forward periscope tube showed that the plug had seated on the bottom of the gland and that both plug and gland were loose. It was deduced that the withdrawal of the periscope had disturbed the packing in the stuffing-box above the gland and that air was escaping between the gland and the periscope tube.

Fig. 11 is a diagram of the bottom section of the periscope tube, from which it will be seen why the tapered end of an ordinary plug allowed the escape of air between the gland and the periscope tube given that the packing in the stuffing-box had been disturbed. For the purpose of overcoming this situation, an expanding plug was designed and constructed so that it could reach up to the "U" leathers in the periscope tube and be sealed by expansion at its inner end against the neck ring of the stuffing-box.

Fig. 12 is a diagram of the expanding plug, which is self-explanatory.

The fitting of this plug did not bring all the difficulties to an end. When divers descended on the afternoon of October 20th to make connections to the air injection valves fitted to the after external tanks it was found these were buried in mud and that the stern of the submarine had settled in the mud during the periods of bad weather, and that the tail was just clear, from which it followed that the after hydroplanes were buried in approximately 6ft. of mud. On the following morning a diver was sent down with a deck hose to try to clear the buried air cocks, but after an hour's work he failed to locate them. Blowing of the compartments forward of the No. 40 bulkhead and of the main body of the submarine, as well as of the Nos. 2, 3, and 4 port and starboard external tanks, was commenced, and was continued until the late afternoon when the 2in. syphon pipe commenced to exhaust air. A diver was then sent down and reported the Nos. 5 and 6 port and starboard air injection valves clear above the mud. The submarine was maintained in a condition of just negative buoyancy during the ebb tide in the hope that the mud would be scoured from the stern. Blowing was resumed on October 22nd, and shortly after midday the bow surfaced and sank slowly, but after 30 min., during which blowing was continued, the bow again surfaced and remained. Air pressure was then released from the forward external tanks to permit the bow to settle again, as it was feared that with the strong flood tide it might be uncontrollable. Divers were again sent down and found the after hydroplanes and propellers clear of the mud, but a big volume of mud was held between the propeller shafts. As it was apparent that with the trim of the submarine by the stern a substantial body of water remained in the after-crew space, a hole was drilled through the pressure hull below that space and an air compressor was kept running all night on the injection valves in the plate fitted over the engine-room hatch.

In the early morning of October 23rd a diver reported that there was a good discharge through this hole, but a leakage of air was discovered from a pipe 6in. in diameter covered with a grating adjacent to the No. 6 port external vent. This was presumed to be an overside discharge from a 100-ton pump, and was plugged. At 2 p.m. the stern came to the surface and blowing was then commenced on the compartments forward of the No. 40 bulkhead, and on the forward external tanks, and at 2.30 p.m. the bow surfaced with a 2 deg. list to port. The submarine was then drawing 17ft. forward and 15ft. 3in. aft, and was taken well up the beach stern first.

Later the bow was hove inshore to a position where the open bow cap of the No. 5 torpedo tube was exposed at low water. The vessel was deodorised and made reasonably fit for entry by persons authorised to take evidence, and thereafter she was towed to Holyhead and drydocked. No damage of any significance had been caused by the salvage operations, and on November 18th we safely delivered her to her birthplace at Birkenhead.

FACTORY SAFETY.—The speeding up of processes and high influx of new and untrained employees into industry have enormously increased the risk of accidents. The Industrial Welfare Society and the National Safety First Association have for this reason produced a little booklet specially designed to draw the attention of new employees, with the aid of humorous illustrations, to the fundamentals of works safety. In addition, there are posters, pamphlets, and various other employee leaflets, many of which are specially applicable at the present time. Any firm interested in this type of literature can obtain full particulars from the National Safety First Association, 52, Grosvenor Gardens, London, S.W.1.

Rail and Road

FIRE-FIGHTING TRAIN ON THE S.R.—The weed-killing train of the Southern Railway Company has been converted into a mobile fire-fighting unit, with a squad of six trained men. It will be used to deal with fires on or adjacent to the company's premises to which access cannot be gained by outside fire-fighting units, or where delay might occur in their reaching a fire.

TRANSPORT IMPROVEMENTS IN CHICAGO.—At a cost of 60 million dollars to be spent during the next three years, the transport facilities in Chicago are to be improved, and a scheme has been prepared to establish a single company to control all forms of public transport. An additional 42 million dollars will be spent during the five following years, principally on new rolling stock.

MEXICAN RAILWAY TO BE CONVERTED TO STANDARD GAUGE.—The Mexican railway, Ferrocarriles Unidos de Yucatan, is to be converted to standard gauge from Merida to Campeche, where it will connect with the Campeche–Puerto Mexico standard-gauge line now under construction. The Department of Communications of the Mexican Government has agreed to cede to the company a certain tax relief to defray the expense.

TROLLEY WIRE ANTI-FLASH DEVICE.—A large number of anti-flash screens are being fitted over the trolleybus conductor wires by the Southampton Transport Department. These screens or shields are being fastened to the suspension insulators, particularly on gradients where the flashing is most noticeable. They consist of curved metal sheets about 25in. long which project about 5in. beyond the end of the suspension where the flash occurs. The flash is masked on a level with the conductor wire by curving the sides of the shields downward.

ALTERATIONS TO AN INDIAN RAILWAY BRIDGE.—The Indian Railway Board has decided to provide in its 1940–41 programme for the re-girdering of the Shershah bridge over the Chenab River near Multan, on the North-Western Railway. This bridge consists of seventeen through type spans, each 200ft. in length, and carries a single broad gauge track and a roadway on the same deck. The new spans are being designed in the office of the Deputy Chief Engineer, Bridges, North-Western Railway, and will carry a single broad gauge track on the lower deck, and an 18ft. roadway on the top booms.

NEW RAILWAYS IN KAZAKHSTAN.—According to the "Russia To-day" press service, during the last two years over 1250 miles of new railways were put into operation in Kazakhstan. This year it is intended to finish the second section of the Akmolinsk and Kartaly line. The Kandagach and Orsk railway being built in the west of the Republic will also be finished before the end of the year. The latter railway will carry nickel ores from the Aktyubinsk Province to the Orsk Combine, and will facilitate the transportation of ore from the chromite mines situated along the route of the railway.

A BIG AMERICAN OIL-ELECTRIC FREIGHT LOCOMOTIVE.—The Electro-Motive Corporation of the United States has been operating for several months a large oil-electric locomotive designed particularly for freight service. As described in the *Railway Age*, the locomotive is made up of two two-unit locomotives, each unit of which is carried on two four-wheel trucks and driven by a 1350 H.P. oil-electric power plant. The two locomotives, coupled back to back, make a multiple-unit locomotive of 5400 H.P., weighing about 912,000 lb., the overall length being 193ft. With all the weight on the driving wheels the starting tractive effort is 228,000 lb., and the locomotive is designed for a maximum speed of 75 miles an hour.

SAVING BRIDGE FALSEWORK FROM ICE.—During the construction of a bridge across the Ohio River at Owensboro, one of the channel spans was supported on four steel falsework bents resting on piles which were suddenly threatened with destruction by ice. The contractor speeded up work and closed the threatened span and swung it free from the falsework. He then decided to save the falsework itself from destruction, so he extended the bridge several panels into the next span and ran his heavy travelling crane out on this cantilever to serve as a counterweight. The falsework was then hoisted up under the completed span, clear of the river, and kept there until conditions were favourable for its removal. As described in *Engineering News-Record* the bridge consists of four river spans, totalling over 2000ft. in length, and carries a two-lane roadway.

L.M.S. RAILWAY SCRAP SALVAGE.—Successful results have already been obtained from a "salvage flying squad," composed of specially adapted railway vans, which is touring 100 stations of the London Midland and Scottish Railway Company in the London area to collect war-time salvage. Already the company has collected in London by this and other means nearly 100 tons of salvage, including scrap metal, waste paper, old rope, straw, timber, &c., found mostly in small quantities at goods and passenger stations. Three salvage-collecting vans are at present operating in the London area, on circuits ranging from three to six days each; the vans are taken from one station to another by ordinary trains, so that the expense of collection is negligible. All the scrap and waste material collected in these vans is taken to a central depot in North London, where it is sorted and afterwards disposed of to the best advantage.

A CONVERTIBLE LANE ROAD.—A recent issue of *Engineering News-Record* describes the constructional features of a new eight traffic-lane road which is being built leading in to the business area of Chicago in the United States. By means of retractable kerbs the road traffic may be arranged with six in and two out lanes, or two in and six out lanes, or four lanes in each direction. In this way the two-way traffic, the heavier current of which naturally reverses its direction each day, is allowed for by the corresponding increase or decrease of the number of traffic lanes. Just over 2 miles of the road is being arranged as described. The retractable kerbs are divided into separate divisions, each of which is operated hydraulically. Each 25ft. length of kerb rests on two hydraulic jacks and six spiral springs. The kerb sections are lifted above the road level and held up by the jacks with the springs in tension. When the pressure on the jacks is released the springs pull the kerbs down.

Miscellanea

OIL ENGINE CYLINDER WEAR.—In the annual report on heavy oil engine working costs of the Diesel Engine Users' Association, Mr. A. K. Bruce gave some figures published in America on the actual liner wear from a group of large stationary oil engines. Averaging the results of 44 four-stroke engines comprising 180 cylinders ranging from 16½in. to 22in. in diameter, with a usual load of 80–95 per cent. of rating, the wear per 1000 hours was 0·0011in. The corresponding figure of an average of 33 two-stroke engines totalling 120 cylinders between 15in. and 20½in. in diameter was 0·001in. The usual load was the same percentage of rating as that of the four-stroke engines.

RESIGNATION OF MR. G. H. NISBETT.—British Insulated Cables, Ltd., announces that, acting on medical advice, Mr. G. H. Nisbett has relinquished his duties as managing director, but will continue to act as deputy chairman of the company. His retirement from the former office brings to a close forty-six years' service as an executive officer of the company, during the last twelve of which he has filled the position of managing director with conspicuous success. As deputy chairman he will continue to be in close touch with the affairs of the company, but will be permitted a greater leisure than his duties have hitherto allowed. Mr. T. H. Martin-Harvey and Mr. W. Travis have been appointed joint managing directors of the company.

RELEASE OF L.C.C. STAFF FOR WAR WORK.—At the last meeting of the London County Council it was announced that, in response to the appeal made by the Minister of Health to local authorities to release employees who are skilled engineers or were formerly employed as skilled workers in the engineering and shipbuilding trades, every officer and employee of the Council who volunteers for work on armaments production and can possibly be spared is to be released. To make the maximum numbers available instructions have been given to eliminate all work not absolutely essential and to carry out the essential work by using only a nucleus of skilled men. All resulting variations of trade practice will be recorded and trade unions will be consulted whenever practicable.

THE COAL PRODUCTION COUNCIL.—The Secretary for Mines makes the following announcement:—Under the leadership of the Coal Production Council, presided over by Lord Portal, Production Committees have now been established in all the principal mining districts to take every possible step to meet the urgent demand for more coal. In order to assist these Committees and to maintain close co-operation with the Mines Department and the Council, the Secretary for Mines has appointed the following Coal Production Advisers for the districts named. Lord Portal will continue to be Chairman of the Council, and other advisers have been added to its membership:—England: North-Eastern, Mr. Clive Cookson; North-Western, Sir Robert Burrows; West Midland, Mr. J. Cadman; Yorkshire and East Midland, Mr. Owen V. Smithson. Scotland: Sir Nigel Campbell. Wales: Lord Portal.

AN AGREEMENT TO PREVENT COLLIERY STOPPAGES.—The Yorkshire Mine Workers' Association has accepted a number of recommendations, drawn up by the Association and the South and West Yorkshire Coalowners' Association, to prevent stoppages and reduce absenteeism in Yorkshire collieries. It is provided that no general notice to terminate contracts shall be given and that no strike shall take place at any colliery in South or West Yorkshire during the war until the machinery for settling disputes has been exhausted. Provision is also made for the setting up of a local committee representing the owners and men with power to inflict fines of not less than half a crown and not more than £1 on men who fail to attend work. If the man fails to pay the fine the case may be sent to the magistrates. Fines will be given to local charities. If branch officials consider that the management of a colliery has been the cause of undue loss of time or of output, they have the right, under the recommendations, to bring a case before the local committee.

AN UNUSUAL PUMP CASING REPAIR.—A method which was adopted to keep a pump with a badly cracked casing in service is described in *Power* by Mr. T. D. Oswald, of Newcastle-on-Tyne. A bad fracture on the pressure side of the casing seriously weakened the flange supporting the outboard bearing of the impeller shaft, and upon dismantling a large section of the pressure side of the casing was found to have been reduced to paper thickness. No spare pump was available and means were adopted to keep the damaged pump working. Stiffening angles were welded between the weakened flange and the sound parts of the casing, but it was not found practicable to weld the crack owing to the rotten state of the metal. It was decided to case the entire pump in concrete and a form was built round the casing leaving the dismantling flanges open. Reinforcing bars were placed in position and the concrete was poured after the outside of the casing had been thoroughly cleaned. The pump was placed in service the following day and has for some time been operating successfully.

A PRESSURE CORE BARREL FOR OIL WELLS.—The exhibit of the Bureau of Mines, United States Department of the Interior, at the eleventh International Petroleum Exposition includes the pressure core barrel developed co-operatively by the Bureau and the American Petroleum Institute. This instrument has been designed to cut cores from oil-producing formations and bring them to the surface of the ground without loss of gas or oil. Many problems relating to drilling and the production of oil could be solved more easily if there was information concerning the actual characteristics and conditions of oil-producing formations. In conventional methods of coring productive oil formations, specimens of the reservoir rock are brought to the surface of the ground, but during the process the pressure in the core drops to atmospheric and the gas associated with the oil in the core expands and escapes. The expansion of the gas drives part of the oil from the core. This loss of oil and gas from core specimens has handicapped engineers greatly in estimating the fluid content of petroleum reservoirs with accuracy.

Air and Water

MERCHANT SHIPPING LOSSES.—During the week ended Sunday, June 16th, ten British ships totalling 47,015 tons, eight Allied ships totalling 31,574 tons, and six neutral vessels of 23,170 tons were lost as a result of enemy action.

NEW GRAVING DOCK IN AUSTRALIA.—A new graving dock is to be built in Sydney Harbour at a cost of three million pounds. It will link Garden Island with Potts Point and the site was recommended by Sir Leopold Savile, who spent some months investigating suitable sites.

WAGES INCREASE CLAIM.—The Confederation of Shipbuilding and Engineering Unions has sent to both the shipbuilding and the engineering employers a claim for a wage advance of 10s. a week. It is understood that no dates have yet been arranged for the discussion of the claims.

LLOYD'S REGISTER OF SHIPPING.—At a special meeting of the General Committee of Lloyd's Register of Shipping, Sir George Higgins was re-elected Chairman for the ensuing year; Mr. Ernest L. Jacobs, Deputy Chairman and Treasurer, and Mr. R. M. K. Turnbull and Mr. Robert Corry, Joint Chairmen of the Sub-Committees of Classification.

AMERICAN AIRCRAFT FOR THE ALLIES.—It has been announced by the Anglo-French Purchasing Commission that orders have been placed to date in the United States for more than 10,000 aeroplanes at a cost of over 250 million pounds. Nearly 2500 machines have already been delivered to the Allies and in addition 20,000 engines have been ordered.

NEW AMERICAN BATTLESHIP LAUNCHED.—The new 35,000-ton battleship "North Carolina" was recently launched at Brooklyn. She is one of the six "Washington" class ships, and has a length of 750ft., a beam of 108ft., and a mean draught of 36ft. Her armament includes nine 16in. guns and twenty 5in. guns. She also carries four aircraft. The quadruple screws are driven by geared turbines and the vessel is designed for a speed of 28 knots.

AMERICAN AIRCRAFT FACTORY EXTENSIONS.—It is stated in *Iron Age* that the United Aircraft Corporation in the United States has approved an expenditure of 8 million dollars by the Pratt and Whitney Aircraft Division, which has already been tripled in capacity during the past twelve months. A contract has also been placed by the Boeing Aircraft Company for extensions to its factory which will provide an additional space of 577,000 square feet at a cost of nearly 2 million dollars.

I.N.A. PAPERS AMENDMENT.—We are informed by the Institution of Naval Architects that the paper on "Longitudinal Strength," by Messrs. J. Foster King and J. Turnbull, has been unavoidably postponed, and that a paper, "Mathematical Ships' Lines," by Mr. F. W. Benson, has been added to the list. Advance copies of this paper may be obtained from the Secretary, and written comments thereon are invited with a view to their publication in the "Transactions." They should be in the Secretary's hands not later than July 10th, 1940.

AIRCRAFT PRODUCTION.—The Minister of Aircraft Production issued the following statement last week:—"I make a report that aircraft production in this country, in every category, has, since May 10th, exceeded the total casualty list, including casualties sustained through accidents at home. The aircraft available of every type now in use exceeds the number of machines at the disposal of the Air Force when the battle broke out. In addition to production, repairs have replenished stocks. There is now on hand a very good surplus stock of engines."

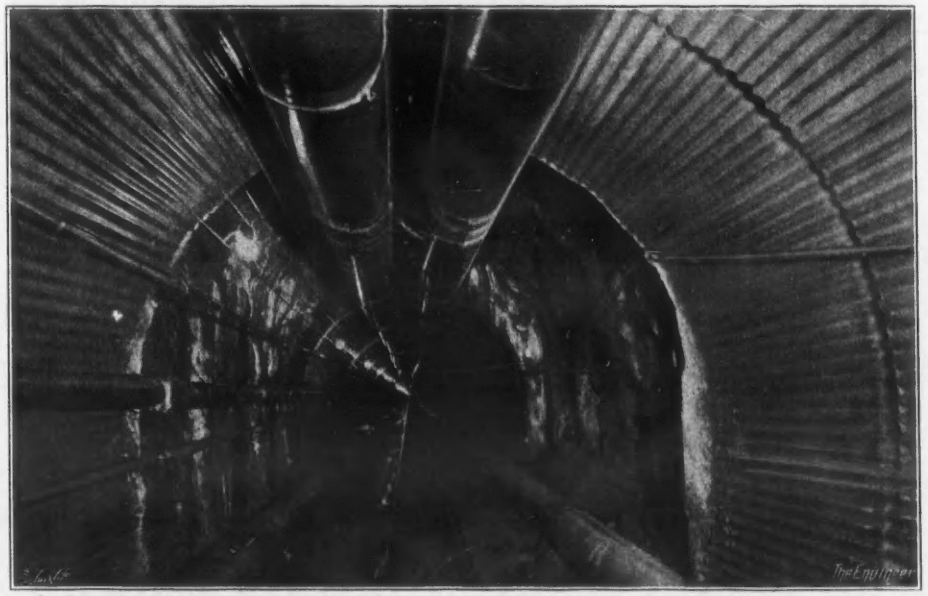
CANADIAN AIRPORT CONTRACTS PLACED.—It is reported in the Canadian Press that tenders have been placed for the construction of three airports which will be built in the Kingston area for the Dominion Department of Transport in connection with the British Commonwealth air training scheme. It is understood the contract price, which will include grading, seeding, fencing, stumping, and building the runways 3600ft. long, is between 400,000 and 500,000 dollars. Canadian authorities have also approved plans for the construction of landing fields in the province of New Brunswick at Chatham, Scoudouc, and Salisbury. Runways at the new fields will be from 1 to 1½ miles in length, and each airport will have two to four runways.

NICKEL-CHROMIUM STEEL FOR AIRCRAFT.—An abstract in the *Nickel Bulletin* says that in order to provide authoritative data for aeronautical designers and engineers, leading American producers of stainless steel have arranged for an investigation of properties, to be carried out at the National Bureau of Standards. It is hoped that the more detailed information thus made available will promote the use of the corrosion-resisting steels in this field, and enable designers to utilise to full advantage the high strength/weight ratios obtainable. Recent experiments indicate the possibility of producing tensile strengths of more than 78 tons per square inch, without loss of ductility, by means of severe cold working, followed by a low-temperature heat treatment.

ITALIAN FIGHTING AIRCRAFT.—The Italian Air Force employs about thirty different types of machines, and it is expected that as the war progresses they will concentrate on one or two of the most advanced types. Foremost amongst the fighters are the Fiat G 50 and the Macchi C 200, both single-seat monoplane types, with a single radial engine. They each carry two heavy machine guns, firing forward. Their wing span is about 35ft., whilst their speed—305 m.p.h. for the Fiat and 313 m.p.h. for the Macchi—is definitely low as modern fighters go. Against this they are reported to be very manœuvrable and sturdily built. Another fighter, a biplane, reminiscent of Britain's obsolescent Gloster Gladiator, is the Fiat C R 42. Italy's best-known bombers are of the three-engine type. The Savoia-Marchetti 79 and 81 are examples, the S.M.79, powered with engines of the Bristol "Pegasus" type, being the more successful. This aircraft has a wing span of about 66ft. and a top speed of 270 m.p.h. Newer are the two-engine Savoia-Marchetti 85 and 86, and the Fiat B R 20. The B R 20 has a speed of about 260 m.p.h., and besides carrying a useful load mounts four guns.

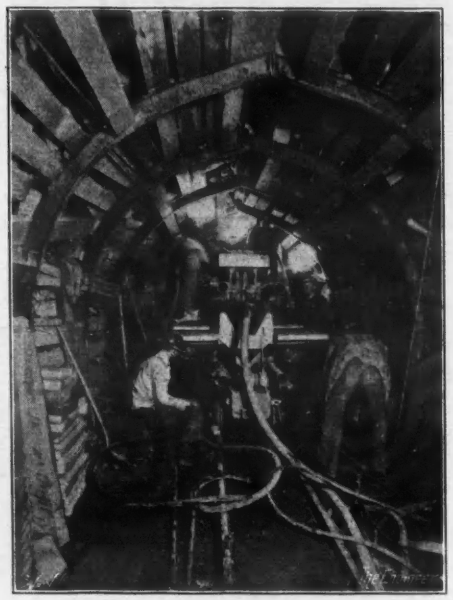
THE MONO BASIN WATER SUPPLY PROJECT, U.S.A

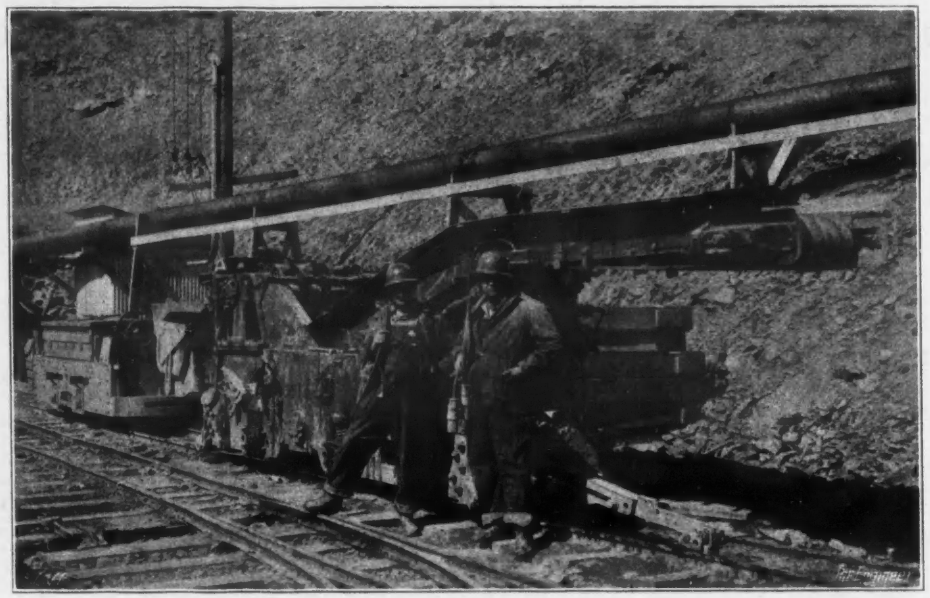
(For description see page 566)



MONO CRATERS TUNNEL
DRILL CARRIAGE

SITE OF GRANT LAKE DAM
COLLAPSIBLE METAL FORMS





MUCKING MACHINE

The Engineer

JUNE 28, 1940

VOL. CLXIX No. 4407

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DESIGN AND OUTPUT

No man is a greater trial to the manufacturer than the insatiable inventor. Hardly has the production stage been reached before he sees where this thing and that could be improved, or has schemed some new device to replace an essential part. Whilst his ideal is perfection, it is ten to one that his business training is too weak to control his mechanical instincts. Many a manufacturer has quarrelled, sooner or later, with the inventor, and many an inventor has maligned a manufacturer for treatment which he had in reality brought upon himself by lack of understanding. Things are bad enough when there is but one inventor; they are ten times worse when there is a board of inventors, to whom all and sundry may make suggestions. Then nothing but the firm hand can prevent the changes or modifications which are the anathema of the producer. Years ago Mr. Henry Ford exhibited such firmness. His method remains as an example to others. He designed the "Tin-Lizzie," and made it to set designs for years on end, despite suggestions and criticism. Then when it had served its day he jettisoned the design and overnight began production on another. Recently he was invited to make war planes, and in reply he offered to produce no less than one thousand per day if he were allowed to mass produce one design and one only. We are more certain that he could fulfil his promise than that any service body would leave him the freedom of action which he enjoyed in the commercial field; and without lack of interference his intentions could not be realised.

It has been said, and probably with a great measure of truth, that before the war the rate of output of British aeroplanes was kept low by continual modifications. Our manufacturers and designers were aiming at the very best, and it seems that they reached it, but at the expense of quantity. The Germans, on the other hand, were resolved to have quantity, even at some cost of quality. It must be confessed that their policy was right, in view of the tactics that they had visualised. Indifferent as their machines may be by comparison with ours, they are good enough for their intended purpose. Their army bombers are apparently not designed for long flights or for difficult evolutions. It was sufficient that they should be able to carry a load of bombs a few miles and discharge them on the troops of their adversaries. Quantity was of far more consequence than quality. The problem as it presented itself to us was never quite the same. We had to anticipate long flights and build machines suitable for them. Clouds of army co-operation machines had not entered into our estimates, or into those of France. In the course of time we shall combine both characteristics, quality and quantity, and our superiority will then begin to tell with ever-increasing impetus. But haste is essential and we have not a shadow of doubt that the Ministry of Aircraft Production is now so concentrating attention on output that a splendid figure is being reached. We must not forget, however, that Germany is doing the same, and there is the possibility that by even greater simplifications of design for mass production she also—if incidental troubles are not intervening—is augmenting her rate of output. How far she dare push simplification is a problem of great moment. It is no secret that our fighters are increasing in numbers, and as their fighting superiority to present German machines of all classes is beyond question, Germany cannot risk the adoption of any simplification that may endanger efficiency, unless, indeed, she holds that huge numbers and colossal sacrifices may achieve the object she has in view.

There is sometimes a misunderstanding of what is meant by quality. We suggest as a definition: "Quality is that attribute which fits a product for its intended purpose." If the purpose is clear and defined, any quality above and beyond what is needed spells inefficiency in production. That does not apply to aeroplanes alone but to all kinds of machinery. Lack of clearness of purpose invariably leads to complication. There is then a tendency to make an all-purpose machine instead of a single-purpose one. It is only when we know exactly what we are going to do with a machine that we can reduce it to its simplest elements. Then even if machines have in the course of years been developed to a certain form we may see our way to cut out certain features which are not essential to a purpose which has for some cause or another become specific. Unfortunately traditional thought often hampers such pruning. But when output, and output, and output is the call of the hour, a fixed resolution to seek for simplification and firmness of purpose to carry it out despite all obstacles are of incalculable importance.

Road Safety

AT a time when the youth of this country is going willingly into danger and men above military age are volunteering for jobs which may involve considerable risk, it may seem strange to hark back to the study of safety on the roads. The subject has become a backwater, rendered even less immediately topical by the cessation of all new road construction other than that of an urgent character. But the virtue of a backwater is its quiet. In studying a subject which, a little while ago, led to a fierce controversy of words we can for a happy space forget that other more pitiless struggle in which the country is engaged and gain thereby a useful relaxation of the mind. Sooner or later—may it be sooner!—the war will be finished and road transport in all its forms will come into its own again unrestricted by the need to preserve petrol for war purposes. Then the attempt further to reduce the risks of the highway will regain its old importance and, maybe, the problem will be seen with a sense of proportion, sharpened anew by the harsh trials through which we are now passing.

We have been induced to enter again into a discussion in which we have frequently taken part in the past by a paper read by Mr. F. A. Rayfield before the Institution of Civil Engineers last April and now published in the *Journal* of that body. It recalls to mind the pre-war controversy between the Ministry of Transport, which took the view that lack of care shown by road users was the main cause of accidents, and the Oxfordshire Surveyor, Mr. Bennet, who claimed to have demonstrated that by correct reconstruction of the roads some 90 per cent. of fatalities could be eliminated. As Mr. Alker Tripp pointed out in the discussion of the paper, that controversy is already dead. All now admit that though the engineer can do much to reduce the likelihood of accidents, the incalculable factor of human weakness cannot be eliminated. The human mind is so constituted that it offers no objection to the taking of a risk, providing only that the object to be gained thereby is valuable enough. Heaven knows that quality was demonstrated magnificently enough at Dunkirk and in the fields of France! But unfortunately on the roads the human mind tends to underrate the risks and over-estimate the advantage to be gained by running them. That is a fundamental fact and is the justification for the propaganda that educates the public in the dangers of the highway. But, in the words of the author of the paper, "While recognising that the human element may be the most important factor in any road accident, the engineer should bear in mind that road conditions are frequently contributory. Although the road engineer's responsibility is impossible to define, it exists nevertheless, and should not be shirked." He goes on to claim that there is still scope for further investigation into the causes of accidents and for detailed analysis of existing statistics. Far be it from us to disagree. In a series of leading articles during the past few years we have been advocating closer investigation of the causes of accidents. But a sense of proportion must be observed. However embracing our knowledge of that subject may become, it can only be fully applied in the construction of new roads or the major reconstruction of old ones. In city streets and built-up areas and on minor country roads the cost of such works is prohibitive. To bring about reductions of accidents in such places reliance must be placed upon detail improvements, the necessity for which can best be indicated by those invaluable weapons, accident maps. Broad knowledge as to how to construct safe arterial roads is not likely to prove of much service in effecting such small improvements, and we fear that, in the absence of the wealth to reconstruct, it will only be by such independent detailed action that the number of accidents will be substantially reduced.

Road safety is frequently treated as a complete subject in itself. In actual fact it cannot be extricated from its entanglement with the many other factors influencing road design and reconstruction. It is necessary to cultivate a detached attitude of mind in which human lives and limbs become but numerical factors in a complex economic problem. We cannot, for instance, say that if the number of accidents at a certain crossing exceeds the numerical value x, then the construction of a fly-over at a cost of £20,000 will be justified. The delays to traffic at the original road junction must be reckoned in the account as well and may well turn out to be the greater influence in the decision to build the fly-over. If, with exaggerated care for human life, the engineer was given a free hand, he could, we believe, by careful road reconstruction throughout the length and breadth of the land eliminate at least 90 per cent. of accidents. But the cost would be appalling and, though traffic fluidity would be encouraged, the erection of guard rails and the regimentation of pedestrians and others with the object of segregating different classes of traffic would subject great portions of the community to inconvenience. Veneration for

human lives cannot be allowed to assume too great proportions. The fundamental question then becomes: How much is an average human life worth in terms of inconvenience imposed upon and cost incurred by the rest of the community? It is a question that unfortunately has no answer. The valuation of human life, whatever the currency chosen, is likely to differ as between one community and another according to the characteristics of the people and the surrounding circumstance. It is likely to change from generation to generation. A tyrant into whose power a whole nation has entrusted itself is now throwing his hordes across Europe. He values human lives like grains of sand as compared with his domination of a Continent.

Time

(Contributed)

IN an atmosphere of unhurried calm the long view is, of course, the right one. We must look forward, we must plan ahead and lay down logically the various successive steps which must be taken to reach the goal to be attained. But calm and leisure have given place to extreme urgency and we must readjust our minds to meet the changed conditions.

We have had ample opportunities in the past to take the long view, but we have invariably deluded ourselves with that most destructive illusion that there was plenty of time. Experience has shown that there was, indeed, in the past plenty of time, if we had used it; but time is not like money or material things; it cannot be stored up, the coinage of time must be used fresh from the mint, or not used at all.

"Here," says Father Time, "is a most priceless gift—one hour. It is yours absolutely to use as you think fit, or, if you choose, to waste; but as I give it to you it is already shrinking in your hand and in sixty minutes it will have vanished from your grasp. It can neither be hoarded, nor can it be replaced. Of course, I shall give you another hour when this one has expired, but each hour that I give you is one less from that indefinite, but strictly limited, number of hours which extend from this present moment to that critical period in the future when, so far as you are concerned, no more hours will be available for the accomplishment of your task, whatever that may be, and it may well be a task on which your own fate, the fate of your country, or even the fate of the world, depends."

Probably one of the worst of the many defects of the democratic mind is that it takes no heed of time, it revels in appointing committees (with no executive powers), it delights in exploring avenues, in leaving no stones unturned, in compiling statistics or filling up forms (or asking others to do so); but if it is asked a straight question to which the only valid answer is "Yes" or "No," it collapses into ineffective dust.

As Captain Cuttle said, "The bearings of this observation lays in the application on it."

We have used up all the hours, months, and years that were available in the past for long-term programmes, and now the critical moment has arrived. There is nothing for it to-day but to put first things definitely first, and this inevitably implies putting second things second. We want planes and anti-plane defences now, to-day, to-morrow, next week, next month; no long-term programme can now mature unless our short-term activity keeps us alive in the meantime.

Every unit of production must be worked on night and day now, and it must be employed on direct munitions in the strictest sense—the ones we can put into the hands of our fighting forces now are those that will count in the issue.

Every man and woman must concentrate on turning every ounce of available material into warlike output now, even at the cost of delay in future output. It is far more important that every existing machine tool should be kept in constant operation night and day than it is to build or import quantities of new machines for use in the distant future.

Every machine tool maker should concentrate his brains and his labour on completing those machines which can be finished quickly and which can immediately be put to work. This may cause delay in future output, but we cannot eat our cake and have it, and the immediate result is the important thing.

Naturally we need reserves, but the fighting line comes first, and if the fighting line does not hold through lack of immediate supplies reserves which are distant, either in time or space, may have little or no effect.

France has shown us clearly how not to do it. When France had time to prepare she threw it away by introducing the forty-hour week, just at the time when every hour should have been used in production. Let us beware lest we waste one of the hours that may still remain to us.

And why not martial law now? We know that it must and will be introduced—probably too late. If it is introduced immediately those who will have to administer it will have some opportunity to organise and to test their organisation—and those who have to obey will be able to accustom themselves to obedience.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PROPORTIONAL DISC LOSSES IN PUMPS AND FANS

SIR,—Mr. Jennings' recent letter[1] drawing attention to the relative unimportance of the disc friction loss in centrifugal pumps and fans of high specific speed opens up an interesting avenue of theoretical study and practical investigation, and his further notes on the variation with specific speed of the other energy losses will be awaited with interest.

The cumulative effect on the performance of a centrifugal pump of all its hydraulic and mechanical losses is shown up best by the overall efficiency (water h.p./shaft h.p.), and the connection between this characteristic and the specific speed has interested certain investigators during the past twenty years or so.

Professor R. L. Daugherty,[2] for instance, has plotted efficiency against specific speed for a large number of turbine and volute type pumps. The mean curves give a maximum efficiency of 0·82 to the low specific speed turbine pump, and 0·80 to the relatively higher specific speed volute type. In both types the efficiency falls as the specific speed is increased or reduced from a certain optimum value.

Professor L. F. Moody[3] has demonstrated after making certain assumptions regarding the losses that the efficiency of water turbines should, in theory, fall with increase of specific speed, and his curves of test figures from actual turbines, and also centrifugal pumps, show this tendency at high specific speeds. The test curves also indicate a fall in efficiency at low specific speeds for both turbines and pumps, a peculiarity which is not covered or explained by the theory, probably because the frictional losses were assumed proportional to the squares of the various velocities, viscosity of the fluid and roughness of the surfaces being neglected.

T. Y. Sherwell and R. Pennington[4] have published approximate curves of efficiency plotted against specific speed for turbine, volute, mixed-flow, and axial-flow or propeller pumps. The maximum efficiencies of these types of pump, which are arranged in increasing order of specific speed, are from the curves 0·78, 0·86, 0·81, and 0·77. Here, also, for each type the efficiency falls as the specific speed is raised or lowered from the optimum value at which the maximum efficiency occurs.

The general conclusion that may be drawn from the above figures is that both low and high specific speeds are associated with low efficiencies in pumps and turbines in general, and in pump and turbine types in particular, but in a contribution to Sherwell and Pennington's paper, Mr. J. W. W. Drysdale[5] wrote that he did not think that the axial-flow pump need have an efficiency lower than that of other types, and drew attention to the high efficiencies (up to 0·85) attained by British and Continental mixed-flow and axial-flow pumps.

Mr. Drysdale's championship of the high specific speed pump has recently received ample support in curves published by Mr. H. Hillier,[6] indicating maximum efficiencies of 0·84 and 0·81 respectively for mixed-flow and axial-flow pumps, and by Sulzer Brothers[7] showing a maximum efficiency of 0·93 for a medium-sized propeller pump. It will also be recalled that models of high specific speed pumps tested by Professor Daugherty[8] yielded efficiencies between 0·889 and 0·926.

Professors Daugherty and Moody[8] have also recently published test curves showing maximum efficiencies between 0·90 and 0·92 for centrifugal pumps built by American firms and tested in the special pump-testing laboratory at the California Institute of Technology, where efficiencies can be measured within the remarkable limits of accuracy of plus or minus one-tenth of 1 per cent.

It will be apparent from the contradictions presented by the foregoing record of test results that there is plenty of scope for an investigation of the manner in which pump efficiency is affected by specific speed, and Mr. Jennings' first theoretical contribution in this direction is to be welcomed.

G. G. MCDONALD, Ph.D., M.I.E.S.
Engineering Department,
The University, Glasgow, W.2,
June 17th.

[1] "Proportional Disc Losses in Pumps and Fans," THE ENGINEER, Vol. 169 (1940), page 519.

[2] "Hydraulics," second edition. McGraw-Hill, New York, 1919, page 260.

[3] "Water Turbine Performance Trends," Trans., A.S.M.E., Vol. 43 (1921).

[4] "Centrifugal Pump Characteristics, &c.," Proc., I. Mech. E., 1932–33, page 625.

[5] *Ibid.*, page 697.

[6] "Modern Marine Auxiliary Plant," Trans., I.E.S., Vol. 79 (1935–36), page 285.

[7] The *Sulzer Technical Review*, No. 2, 1939, page 20.

[8] Contributions to the discussion of Mr. O. A. Price's paper, "Vortex Pumps," *Journal*, I. Mech. E., Vol. 142, No. 5, March, 1940, pages 444–45, 453–54.

Sixty Years Ago

THE STRENGTH OF RAILWAY BRIDGES

LATE on the night of June 17th, 1880, an accident occurred on the Hereford, Hay and Brecon Railway, worked by the Midland Company, which, but for blind chance, might have been far more serious from the point of view of fatalities than the Tay Bridge disaster. Between Hay and Brecon a three-arch bridge about 40ft. long and 20ft. high spanned the River Wye. The river was in heavy flood and as a goods train was crossing the bridge—or possibly just before it crossed—the structure collapsed. The train was precipitated into the water below, the engine driver being killed and the fireman seriously injured. A short time previously a heavily laden excursion train consisting of twenty-four coaches drawn by two engines had crossed the bridge in safety. Had the structure collapsed during its passage fully 500 or 600 persons would have been killed or injured. In a leading article in our issue of June 25th, 1880, we took this accident as a text and called attention to the great possibility that many of our railway bridges, particularly those ranging from 20ft. to 80ft. in span, were in a dangerous condition and liable to cause a serious disaster at any time. The collapse of railway bridges was by no means rare. Some years previously a small bridge near Beckenham had fallen as a result, so it was said at the time, of a flood in the stream which it crossed, and many lives had been lost. In America the Ashtabula bridge disaster had produced a casualty list as extensive as that which accompanied the fall of the Tay Bridge. In 1879 two bridges, one at Llandulas and the other at Aber in North Wales, had been "washed away" and only exceptional vigilance had avoided one and perhaps two frightful calamities. Some of our railway bridges had, we said, been in service for from thirty to fifty years. It seemed to us certain that not a few of them were now in a dangerous condition, either by reason of their decay or because of the increased loads which they were being called upon to bear. When they were built a 25-ton engine hauling a 15-ton tender was abnormal rather than the reverse. To-day, we said, certain express engines with their tenders weighed together as much as 72 tons. Yet the same bridges were supposed to be capable of carrying them. We gave several disquieting illustrations from our own experience of railway bridges which were still in service, although patently defective. Recently, we said, we had examined several small underbridges on a main line railway. In every instance we had found the brickwork of the abutments shaken and the landings on which the girders rested broken. We knew, too, of an 18ft. span bridge near London consisting of cast iron girders resting on brick abutments which for a long time had been propped up by means of timbers inserted between the abutment faces to keep them apart. All over the country small bridges could be found with the brickwork or stonework of the abutment faces shaken, and in some cases with the arches split right through. Abnormal flooding might precipitate the collapse of a bridge, but we felt sure that in many cases the failure was initiated by overloading and long-continued decay.

MORE MINISTRY OF LABOUR TRAINING CENTRES.—Three more training centres are to be established by the Ministry of Labour. One at Preston will be adapted to train 800 men, one at Coventry 700 men, and the one at present in Glasgow is to be extended to give space for training 1000 men. It is stated to be the aim of the Ministry to provide facilities for the training of 100,000 men a year.

Natural Gas Engine for Trinidad

By W. A. TOOKEY, M. Inst. C.E., M.I. Mech E.

No. II

(*Continued from page 552, June 21st*)

IGNITION

THE ignition set was designed and manufactured complete by Lodge Plugs, Ltd., of Rugby, and the equipment consists of twelve double-output high tension coils, worked from 10 volt nickel-iron batteries, supplying two plugs per cylinder. These plugs are operated in series and the coils are, therefore, designed to give 15,000 volts. Insulation for this voltage under tropical conditions presented a difficult condenser problem, which was solved by embedding the plates in a special heat resisting wax. Each sparking plug is 15in. long and the complete ignition equipment weighs nearly half a ton. The two special six-way contact makers run at half engine speed, and incorporate micrometer adjustment for the timing of each cylinder.

Apart from the difficulty of excluding minute insects from the intricate mechanism, it has been necessary to make the equipment suitable for operation by unskilled labour. In addition, it has to withstand the heat and humidity of tropical conditions.

The Lodge igniter coils and plug connections to each cylinder and one of the special six-way contact makers for timing the ignition are shown in Fig. 4 (*ante*), which is taken from a photograph of a portion of the engine when on the test-bed at Sandiacre. A close-up view of one of these contact makers is shown in Fig. 7 and clearly shows the micrometer adjustment provided for timing the spark independently for each cylinder. A section through the combustion chamber of one cylinder shows—Fig. 8—the positioning of the ignition plugs. The magneto ignition arrangement and leads for coil ignition are shown in Fig. 9. Preferably the engine is operated by the magneto ignition device but the coil arrangement is provided as an alternative.

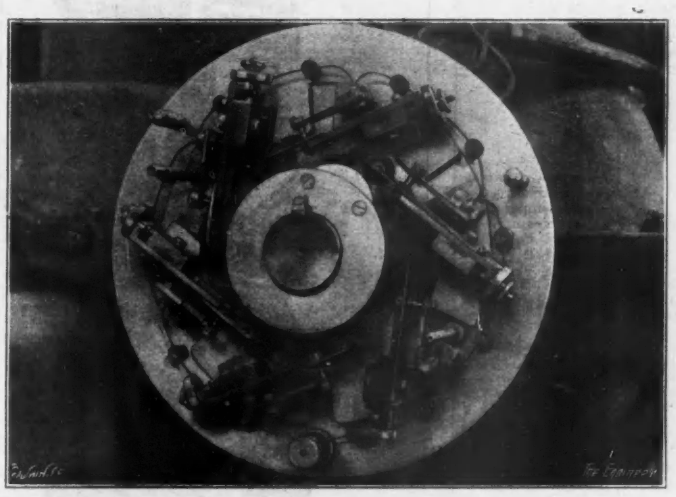


FIG. 7—CONTACT MAKER GEAR

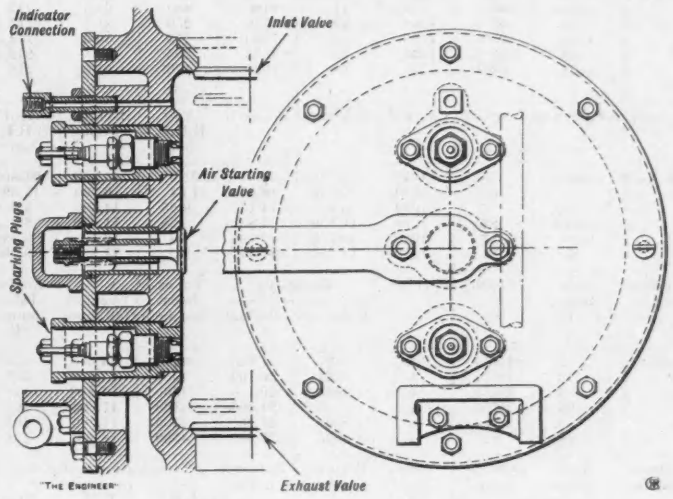


FIG. 8—PLAN AND SECTION OF CYLINDER HEAD

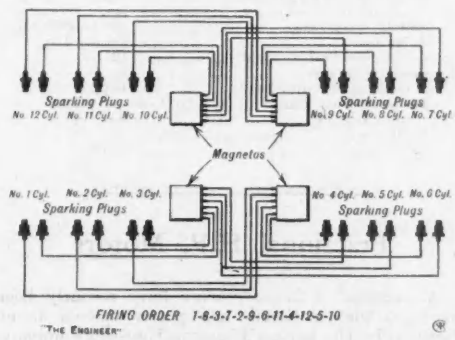

Sparking Plugs
No. 12 Cyl. No. 11 Cyl. No. 10 Cyl.
Sparking Plugs
No. 9 Cyl. No. 8 Cyl. No. 7 Cyl.
Magnetos
No. 1 Cyl. No. 2 Cyl. No. 3 Cyl.
Sparking Plugs
No. 4 Cyl. No. 5 Cyl. No. 6 Cyl.
Sparking Plugs
FIRING ORDER 1-8-3-7-2-9-6-11-4-12-5-10
"THE ENGINEER"

FIG. 9—IGNITION ARRANGEMENTS

LUBRICATION

The pistons and small end bearings are fed from double plunger forced feed lubricators driven from the camshaft, the pistons have but one feed to each on the top of the liner.

A gear wheel pump, taking its oil from a main tank arranged below the level of the bed of each group of six cylinders, delivers oil through a bus main to four branches, each leading to a main crankshaft bearing. Passages are drilled thence through the crank web to conduct oil to the three crank pins. The surplus by-passed oil passes to the gear-case and drains to the main lubricating oil tank. A portion of this oil is conducted to a centrifugal separator and after being re-conditioned by this means is returned direct to the main tank. The capacity of the separator is such that the whole of the oil in the system is treated once every fifteen to twenty hours. The control of the rate of flow through the separator can be observed from a sight glass.

Crankcase guards of fabricated steel are bolted down to machined surfaces on the top of the bed casting, making an oil-tight joint.

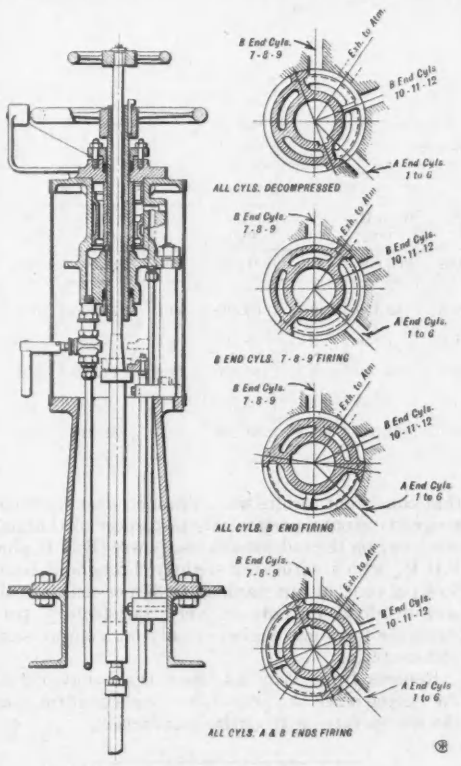

B End Cyls. 7-8-9
Exh. to Atm.
B End Cyls. 10-11-12
A End Cyls. 1 to 6
ALL CYLS. DECOMPRESSED
B END CYLS. 7-8-9 FIRING
ALL CYLS. B END FIRING
ALL CYLS. A & B ENDS FIRING
"THE ENGINEER"

FIG. 10—STARTING CONTROL PILLAR

STARTING AND BARRING GEAR

Besides a hand barring lever for use in emergency, the engine is fitted with a compressed air motor barring arrangement. Compressed air at 250 lb. per square inch is used for starting through a hand operated control stop valve. Cam operated air-distribution valves are connected to each cylinder with non-return valves at each branch of the starting air main. A centrally situated control pillar enables the whole starting mechanism to be operated quite simply by one man. Fig. 10 indicates how this is contrived by relative movements of the larger handwheel whereby after all cylinders have been decompressed by the admission of compressed air through the side lever-operated air cock halfway up the standard, the main compressed air valve is manipulated by the smaller handwheel at the top of the control pillar. This sets the engine in motion and when cylinders 7, 8 and 9 begin to fire normally the larger handwheel is turned through sixty degrees, which puts these three cylinders on full compression pressure. The next cylinders to fire will be 10, 11 and 12 and these in turn are put on full compression. Thus all the six cylinders at what is called the B end of the engine are then at work. The next turn of the larger handwheel through a further sixty degrees brings all the six cylinders at the A end into operation with full compression. All that remains for the operator to do is to close the lever operated de-compressing cock and to close also the main compressed air valve by means of the smaller handwheel.

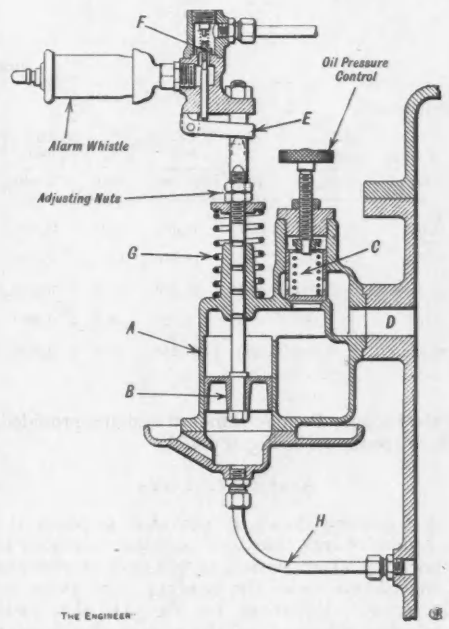


FIG. 11—ALARM APPARATUS

A sectional view of the pillar is given to the right of Fig. 10. Provision is also made for controlling the supply of air to the barring gear motor.

GOVERNING

The normal engine governing mechanism actuates four air and gas throttle valves to give "constant quality" governing—one valve for each group of

three cylinders. Provision is made for suitably adjusting the gas and air throttles which connect up to separate manifolds so that the mixing of gas with air takes place at the admission valve on each cylinder. For an alternator periodicity of 60 cycles per second the engine speed must remain steady at 212 r.p.m. and to ensure that no deviation occurs on changes of load an isochronous governor of the Woodward type is provided. In this device any increase or decrease of speed causes a pilot valve to move under oil pressure and this actuates the controls of fuel mixture so as to keep the desired speed constant at all loads. Dials on the instrument show the governor position in relation to the load limit and the departure from exact synchronisation.

Additionally an emergency overspeed governor termined pressure. Any oil leaking past the piston is drained away by the pipe H.

TRIALS AT FOREST RESERVE, TRINIDAD

The table given herewith summarises the results of six tests separately made on the set at site. Test 1 was at full load for 12 hours with water resistance or at practically unity power factor, and thus instead of 1000 kW at 0·77 power factor, for which it was designed, the output of the set was 1148 kW, equivalent to 1640 B.H.P. from the engine rated at 1500 B.H.P. An overload test, No. 6, was at 1225 kW (1748 B.H.P.) for one hour. And other tests were made of two hours' duration at quarter, half and three-quarter load with a further 3½ hours at 1000 kW.

It will be noted from the tabulated heat balance

Acceptance Tests of 1000 kW Generating Set

Power	kW	Alt. eff.%	B.H.P.	I.M.P.	I.H.P.	F.H.P.	Mech. eff. %	R.P.M.	Baro. in. Hg.	% Rel. Humid	
Test No. 2	231	—	380	34·75	985	605	38·6	214	29·97	69	
3	500	92·0	730	41	1160	430	63·0	213	29·94	69	
4	754	93·5	1080	47	1330	250	81·5	212·5	29·9	69	
5	1024	93·9	1465	58	1640	175	89·0	212·5	29·84	69	
1	1148	93·9	1635	65	1835	205	88·5	212	29·92	71	
6	1225	93·9	1750	68	1920	170	91·0	212	29·88	71	
Gas	S.Gr. wet	Temp. °F.	Cal. Val.	Ft³/hour	Ft³/kWh	Ft³/ B.H.P.-hour	B.Th.U./ kWh.	B.Th.U./ B.H.P.-hour			
Test No. 2	0·681	79	1010	8,210	35·6	21·6	35,950	21,800		NOTE :—Cubic feet per hour corrected for temperature and pressure to 60 deg. Fah. and 30in. Hg.	
3	—	82	1010	9,780	19·6	13·4	19,700	13,520			
4	—	82	1010	10,640	14·15	9·85	14,300	9,950			
5	0·673	82	1010	12,150	11·85	8·28	11,970	8,360			
1	0·68	83	1010	13,720	12·00	8·4	12,100	8,480			
6	—	82	1010	14,350	11·71	8·2	11,820	8,300			
Cooling water	Inlet temp. ° F.	Depth in.	Feet/sec.	Quantity		To exhaust Gals./hour	To engine Gall./hour	Engine Inlet temp. ° F.	Engine Outlet temp. ° F.	Temp. Rise ° F.	B.Th.U./ hour × 10⁶
				Gals./sec.	Gals./hour						
Test No. 2	82	1·435	4	4·97	17,900	4300	13,600	98	116·5	18·5	2·53
3	92	1·625	4	5·63	20,100	4300	15,800	101	123·5	22·5	3·56
4	96	1·625	4	5·63	20,100	4300	15,800	110	129	19	3·02
5	98	1·750	4	6·08	21,900	4300	17,600	108	130	22	3·88
1	95	1·750	4	6·08	21,900	4300	17,600	108	131	23	4·1
6	98	1·810	4	6·25	22,600	4300	18,300	106	133·5	27	4·5
Piston cooling	Inlet temp. ° F.	Outlet temp. ° F.	Temp. rise ° F.	B.Th.U./ hour × 1000	Exhaust gases	Temperature in deg. Fah.			CO_2 per cent.	O_2 per cent.	Excess air per cent.
						L.H.	R.H.	Mean			
Test No. 2	124	146	22	52·8	Test No. 2	797	832	815	—	—	—
3	124	162	38	91	3	1093	1067	1080	7·0	8·0	44·5
4	124	176	52	125	4	1120	1129	1125	7·4	6·5	40·5
5	124	180	56	134·5	5	1135	1147	1141	—	—	—
1	120	184	64	153·5	1	1150	1159	1155	8·0	7·0	45·5
6	123	188	65	156	6	1183	1173	1178	8·9	5·3	30·5
Governor	Load limit	Area of air port	Area of gas port	Air/gas ratio							
Test No. 2	3·25	5·4	0·196	27·5							
3	4·0	7·84	0·254	30·8							
4	4·55	8·40	0·	31·6							
5	6·05	13·04	0·336	38·8							
1	7·3	14·52	0·36	40·4							
6	8·9	17·76	0·407	43·6							

Heat balance

Test number	2		3		4		5		1		6	
	B.Th.U./ min.	%	B.Th.U./ min.	%	B.Th.U./ min.	%	B.Th.U./ min.	%	B.Th.U./ min.	%	B.Th.U./ min.	%
Input	138,200	100	164,500	100	179,000	100	205,000	100	231,000	100	241,500	100
Heat to B.H.P. ...	16,000	11·7	31,000	18·9	45,800	25·6	62,150	30·4	69,500	30·1	74,300	30·7
Heat to F.H.P. ...	25,800	18·7	18,250	11·1	10,600	6·0	7,450	3·6	8,700	3·8	7,220	3·0
Heat to jackets ...	42,100	30·4	59,300	36·0	50,500	28·1	64,600	31·5	68,500	29·6	75,000	31·1
Heat to pistons ...	880	0·6	1,515	1·0	2,080	1·2	2,245	1·1	2,560	1·2	2,600	1·1
Heat to exhaust ...	53,420	38·6	54,435	33·0	70,020	39·1	68,555	33·4	81,740	35·3	82,380	34·1

of the Crossley Premier standard design is provided. These are shown in Fig. 6 (*ante*).

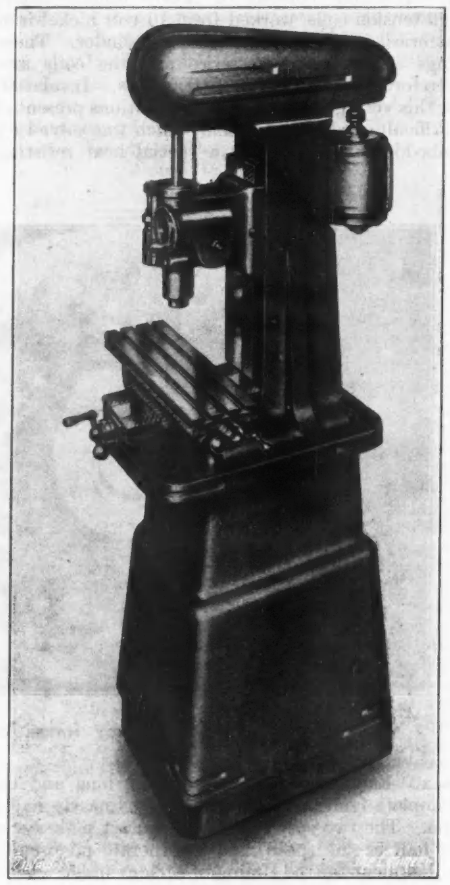
ALARM APPARATUS

A signalling device is provided to warn the attendant of irregularity of operation in regard to lubricating oil circulation, as well as of overloading as mentioned under the heading "air cooler for alternator." Referring to Fig. 11 the main lubricating oil supply to the system after passing through the oil cooler is delivered under pressure to one side of the alarm body A and above the spring loaded piston B. The valve C controls the delivery pressure, excess oil flowing directly into the gear-case through the passage D. The oil pressure depresses the piston B clear of the trip lever E controlling the compressed air valve F. Loss of pressure causes the piston B to rise and it will be seen that when the end of the piston rod engages the lever E the compressed air valve F will be opened admitting air to the alarm whistle. The loading on the spring G can be adjusted so as to permit the alarm being given at any predethat consistent results were obtained over the wide range of outputs, particularly in respect of thermal efficiency on the indicated horse power (B.H.P. plus F.H.P.) which varied but slightly throughout from 30·4 per cent. at quarter load to 34 per cent. at full and overload outputs—a very satisfactory performance for a gas engine of only 5·2 compression volume ratio.

Reports from Trinidad upon the behaviour of the engine since the acceptance trials confirm that the set operates with entire satisfaction.

Vertical Miller and Borer

THE accompanying engraving illustrates the "Vernon" vertical milling machine and jig borer, developed by Machinery Manufacturing Company, Vernon Branch, Los Angeles, California. The Broadway Engineering Company, Ltd., of Carlisle Road, Hendon, London, N.W.9, has been appointed sole agent for that American company in this country. The machine has been designed especially for work on jigs, fixtures, dies and general milling operations. It can be used for laying out various jobs requiring high accuracy and can be equipped with dial indicators and measuring plugs for precise work. A profiling attachment can be used for duplicating work within the range of the machine. It has a maximum distance of 10½in. from the top of the table to the bottom of the spindle. The quill is arranged so that slow feed is provided by hand wheel, graduated to 0·001in., or the slow traverse can be disengaged and a rapid one engaged by merely turning a knurled knob. The rapid one-to-one hand traverse greatly increases speed in drilling operations, and in milling out cavities for dies and similar parts. The spindle



VERTICAL MILLER AND BORER

drive is equipped with back gearing and provides eight spindle speeds. The following table gives particulars of the floor model. The bench model, without pedestal, weighs 500 lb. A ½ H.P., 1750 r.p.m. motor is required to drive this machine.

Overall height	71in.
Floor space required	38in. by 33in.
Height from floor to table top	41in.
Maximum collet capacity	½in.
Spindle speed range	250 to 4200 r.p.m.
Table size	6in. by 21in.
Longitudinal table travel	12in.
Cross table travel	6in.
Movement of sliding head	10½in.
Distance from centre of spindle to column ways	6in.
Quill travel	3in.
Net weight	700 lb.

Fractional H.P. Motors

A NUMBER of improvements have recently been made to the fractional horsepower motors manufactured by the British Thomson-Houston Company, Ltd., of Rugby. As a result of investigations carried out on wire insulation, new forms of insulated wire have been adopted on certain sizes of motor. This change has enabled the maximum amount of copper to be utilised, thereby improving the performance characteristics. A new thermal overload device of the self-resetting type, which has been introduced for building into the interior of the motor, is of a simpler and cheaper construction and more reliable than the type which is attached to the terminal chamber. It is directly affected by the heat of the motor and will therefore trip not only as a result of stalling or excessive overloads, but also as the result of a sustained overload of a moderate character which might otherwise cause permanent damage to the windings. Detail improvements have also been embodied in the resilient mounting of B.T.H. fractional horsepower motors, and the design of the automatic belt tensioning device has been changed to give improved characteristics with simplified construction. Investigations have been carried out in regard to the detail electrical losses in fractional horsepower

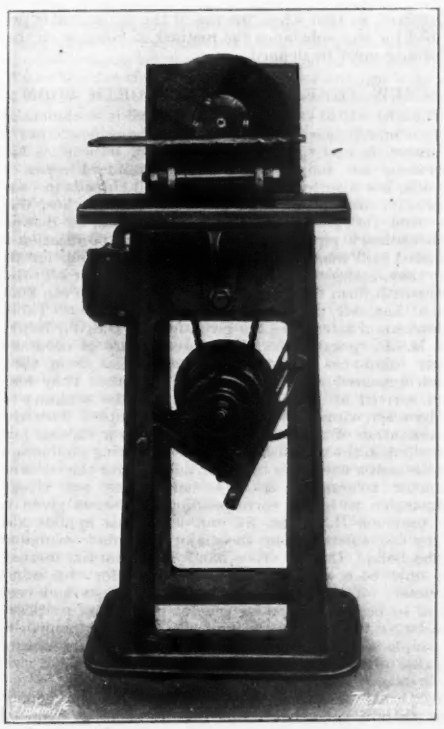
motors. These investigations have enabled improvements in the efficiency and the characteristics of the motors to be obtained by special selection of the materials and treatment of these materials during the process of manufacture. Among various other developments the following are worthy of note. Spigot mounted ball-bearing motors have been available for some time in the smaller frame sizes. This construction has now been extended to the larger sizes of fractional horsepower motors. Totally enclosed fan-cooled construction has been developed for the whole range of A.C. motors from ¼ H.P. to 1 H.P. A new design of humidifier motor has been

RESILIENTLY MOUNTED FRACTIONAL HORSEPOWER MOTOR

developed, of which a large number have been sold for use in the textile industry, the single-phase and three-phase models being interchangeable. The accompanying illustration shows a resiliently mounted fractional horsepower motor with self-acting belt tension adjuster.

A New Filing Machine

A NEW filing machine known as the "Rindis," which has recently been placed upon the market by Lorant and Co., Ltd., 98–100, Croydon Road, London, S.E.20, is shown in the accompanying engraving. As will be seen, this machine comprises a compact pedestal-mounted, motor-driven unit which occupies



FILING MACHINE

a relatively small floor space. Filing is done by a rotating disc about 10in. diameter on which cutting teeth are milled in either face. The undercut shape of the teeth is such that the chips do not clog. They fall down into a tray below the work table. A wide variety of metals and materials may be filed on the machine upon which both roughing and finishing cuts may be done with the same disc. Work is held against the disc by hand, a heavy pressure being exerted for roughing and a corresponding light pressure for finishing cuts. We are informed that the filing discs retain their sharp cutting edges for a long period and when blunt can be repeatedly resharpened.

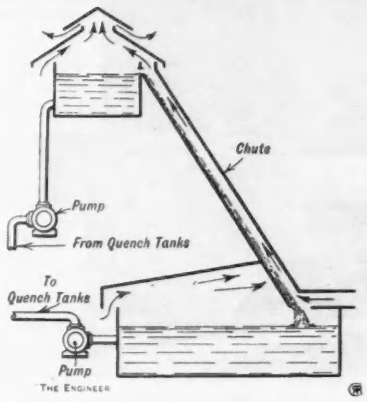
The work table has slots cut in it for the fixing of stops and production jigs and fixtures, and it can be swivelled on its spindle to permit the filing of angular faces. This table is 14½in. long by 6in. wide, and is therefore capable of accommodating a fairly wide range of work.

The ½ H.P. driving motor is mounted on a swivelling base in the framework of the stand, and, by a simple locking arrangement, is rapidly and easily lowered to take up any stretch in the belt. The disc spindle is mounted on ball bearings which take the axial and radial thrust imposed during the cutting operation. It is driven by an endless belt, from the motor, through a nine-speed gear-box which gives a range of speeds between 85 and 360 r.p.m.

Cooling System for Quenching Oil*

HEAT treating shops frequently find that the cooling of quenching oil in summer is a costly and troublesome affair. However, for the small shop, where sufficient work is oil quenched to require cooling of the oil, it is possible to use a quench tank and water cooling system. In such a cooling system oil is pumped through a small tank containing a coil which is cooled by city water. The unit is compact and easy to build and parts for the cooling system can be purchased from sources specialising in that type of equipment. The same idea on a larger scale can, of course, be adapted to several quench tanks.

Where the quantity of oil to be cooled runs into thousands of gallons, water cooling is generally too expensive, for a large amount of water is required, and



COOLING SYSTEM FOR QUENCHING OIL

unless some other useful function can be found for the water it ordinarily goes directly to the drain.

One system which the Lindberg Engineering Company, Chicago, has found to do a good job of keeping large quantities of oil cool is illustrated in the accompanying sketch and photograph. In this system the hot oil leaves the quench tanks and is pumped to a reservoir tank on the roof of the building. Here it overflows down a sheet metal chute, where it cools and goes into a second reservoir at ground level, from which it is pumped back to the quench tanks. The whole operation is, of course, continuous.

Approximately 9000 gallons of oil are contained in the complete system, and during the three years it has been in operation the company has been able to maintain oil temperatures at 140 deg. Fah. to 150 deg. Fah. on the hottest summer days. The system, incidentally, is patterned after a similar one at the Vincent Steel Process Company, Detroit, and has proved thoroughly dependable, as witnessed by the fact that it has never been out of service even for a single hour due to trouble.

As indicated in the sketch, all three units in the cooling system—the roof tank, chute and storage tank—are provided with hoods and air circulates freely in them. Dimensions of the chute are approximately 6in. deep by 24in. wide by 24ft. long, and circulation of air here is of considerable importance. Of particular importance also is the coarse wire mesh screen (approximately 1in. by 1in. openings), which is laid in the chute and over which the oil must pass. This screen breaks up the flow of oil into ripples and permits more rapid heat transfer to the air than a solid stream.

The hoods or covers are designed so that no rain or snow finds access to the system, and yet air can freely enter and leave. This same system can be readily adapted to smaller or larger installations and because of its simplicity can be constructed for a reasonable sum.

The complete system used by Lindberg, exclusive of quench tanks which were already installed, cost the company approximately 500 dollars. Smaller systems would, of course, cost less. The operating cost is very low, as it consists mainly of electric power to run the two pumps in the system.

* The *Iron Age*, May 30th, 1940.

American Engineering News

Mass Production Developments

IN the present move for rapid production of war material in the United States, two important activities are in relation to machine tools and aeroplanes. For the former the manufacturers have organised so that production can go forward rapidly on any designs approved or required by the Army and Navy. A committee representing these departments and the manufacturers will determine specific requirements, and the industry will undertake to make deliveries in times specified by expanding their facilities and working forces, and also by subletting production of parts or complete machines to various factories not engaged in important Government work. The industry will also inaugurate a comprehensive programme for training the additional men required to speed the production. Orders for national defence requirements are to have precedence. As to mass production of aeroplanes to overcome the present deficiency in numbers, an obstacle is the continual changing of designs, even when the changes represent real improvement. What is needed is the production of some approved design of proved merit by thousands upon thousands. If, after a few hundreds are produced to a given design, certain changes are made, then production is halted, new plans must be made and distributed, and the men trained according to the new plans. Mr. Ford has said that he can produce 1000 planes daily on any one approved design. It was suggested to him that the aeroplane is a very special kind of machine, to which he replied that so was the automobile when its mass production was started; 1000 planes of a good and proved design are better than 10,000 planes of possibly improved design on paper.

Standardising Steel Specifications

Standardisation of steel production in order to eliminate a number of special steels of limited volume and high cost has been proposed to the American Iron and Steel Institute. It is estimated that about 200 chemical combinations might be classified to supersede the present many hundreds of combinations. The bulk of the steel business is done with twenty compositions, but there is a continual flood of thousands of patents on steel, involving chemical composition, some comprising as many as seven elements. In fact, many so-called specifications are merely descriptions of proprietary materials. Since excellent steels were produced before the chemist became such a large factor in manufacture, there is a question as to the extent to which his participation is really essential. Most steel is ordered by size or weight, or with certain physical characteristics to be determined by test or—more rarely—by limiting certain elements regarded as impurities. But there has developed a practice of writing specifications combining all three methods although with insufficient information for properly filling any one of the three requirements. The argument is made that it should be economically worth while for the user to consume more of the steels that are produced in large quantity; and, on the other hand, an economic penalty should be imposed on the user who insists upon a specific consideration of his problems. While the steel industry can produce any grade of steel for specific purposes, it should not be expected to do so unless at an adequate price. In many cases where chemical composition is specified by a certain range of definite amounts of the more important elements, these amounts are really so narrowly limited that good methods of analysis would show results varying by more than the so-called chemical spread as specified. The basic open-hearth process dominates the steel industry and produces 90 per cent. of the steel manufactured.

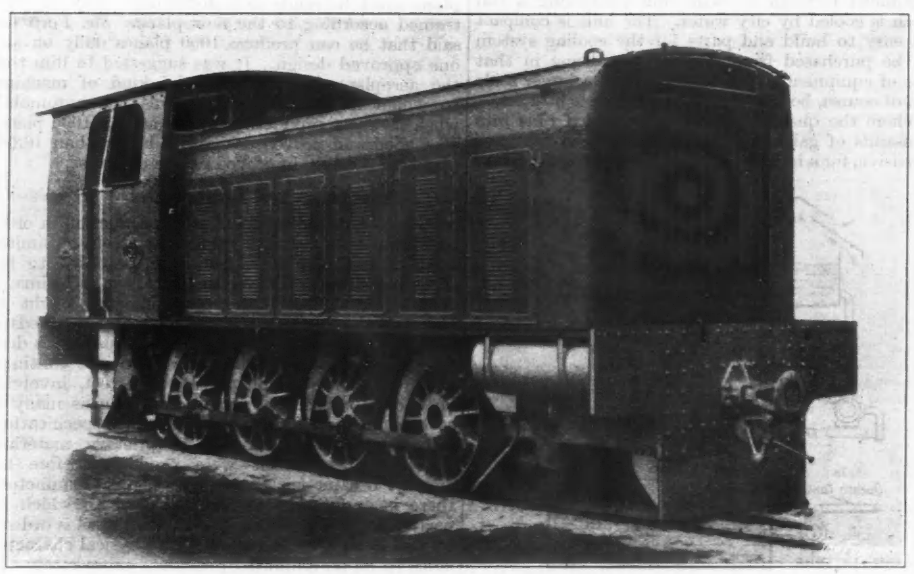
American Merchant-Marine Progress

About sixty-six merchant vessels of various types now under construction for the United States Maritime Commission aggregate some 602,000 gross tons, and are part of a programme for the building of 500 ships in ten years. The largest is the transatlantic liner "America," launched last year; its two sets of turbines with double-reduction gears will drive twin screws with 34,000 shaft H.P. Other vessels completed, launched, or under construction include twelve high-speed oil tankers, four fast—18 knot—cargo liners, three combined passenger and cargo liners, and twenty moderate-speed cargo liners and combination liners. Steam-engine and oil-engine propulsion are about equally divided, and the marked increase in the latter is due largely to the initiative of the Commission. Enquiries from private firms for oil-engined or motor vessels were received rather coldly by ship-builders, whose experience was mainly in steam. But when the Commission began to design its own ships and engines, and called for tenders, the builders had to give the matter more attention. Different types of power equipment are used. Turbines drive through single-reduction and double-reduction gears; and of ten ships, six have one make of engines, boilers, and gears, while four have entirely different arrangements. Of oil-engined ships, some have four single-acting engines with magnetic couplings and single-reduction gears, while

others have two engines of the opposed-cylinder type. Three high-speed liners for South American service are designed for conversion into aircraft carriers, and the 18-knot tankers are also designed for use as navy auxiliaries. To provide personnel for the new merchant-marine service, the Commission has instituted a training service operated under the management of the United States Coast Guard, and intended to train 3000 men and 300 officers yearly. In addition there is a cadet system for future officers, with three to four years training in officers' duties, navigation, engineering, and other aspects of a modern merchant-marine.

Oil-Engined Locomotive for Trinidad

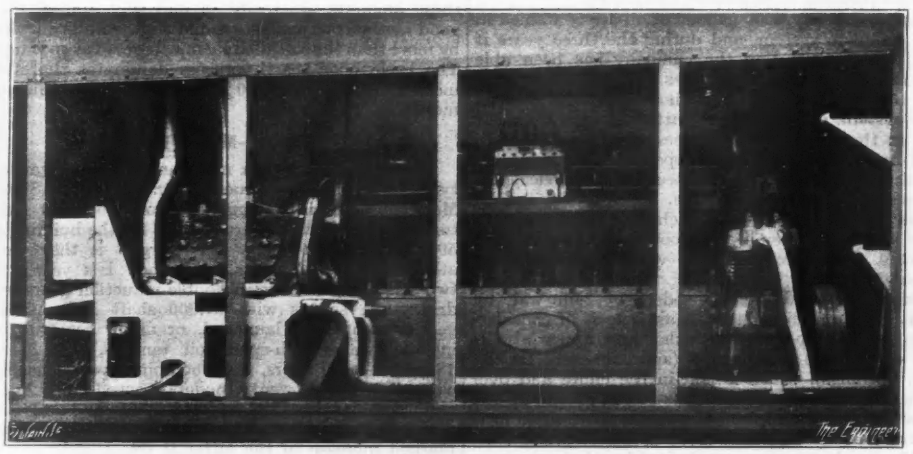
WE illustrate in the accompanying engravings what is claimed to be the largest and most powerful 0–8–0 standard-gauge oil-engined locomotive with mechanical drive built in this country. Built for the Crown Agents for the Colonies for service on the Trinidad Government Railways, the locomotive was designed by the Hunslet Engine Company, Ltd., of Leeds, in co-operation with the Chief Mechanical Engineer of the Trinidad Railways. Since it



LOCOMOTIVE FOR TRINIDAD GOVERNMENT RAILWAYS

is to operate under tropical conditions of high temperature and humidity, special attention was paid to the design of the cooling arrangements and to the ventilation of the cab.

One of the illustrations reproduced shows the arrangement of the oil engine, the auxiliary petrol engine for starting it and the air compressor. The oil engine is a 6 RZ Paxman-Ricardo unit, designed to develop 277 B.H.P. at a one-hour rating at 1000 r.p.m. In design it follows Messrs. Davy, Paxman's



ARRANGEMENT OF STARTING ENGINE, MAIN ENGINE AND AIR COMPRESSOR

usual practice; a deep crank case carries the main bearings and separate "A" frames support the cylinder block, high-tensile steel through bolts being provided to take the firing stresses. Large inspection covers make the big ends and main bearings easy of access. The cylinder liners are of the wet type and are interchangeable, arranged so that they can be inserted from the top, their lower ends being free to expand. Interchangeability is also provided for the cylinder heads, which are of the Ricardo "Comet" pattern. They are spigoted in the top of the liners, clear of the cylinder block, with provision for a free flow of cooling water directly from the liners. Duplicate gear type pumps operate a pressure lubrication system to supply oil to all the engine bearings, including the connecting-rod large and small ends. A large Autoklean oil filter of the self-clearing type is fitted in the pressure system, and special attention has also been given to air and fuel oil filtration.

On the right-hand side of the main oil engine is mounted a Ford "V 8" petrol engine for starting the main engine. This unit is provided with the usual electric starting arrangements and develops 90 B.H.P. at 4000 r.p.m. Control of the petrol engine, which drives the main engine through a Bendix gear and a geared ring on the fly-wheel, is by means of push buttons situated in the cab. It is claimed that this arrangement ensures that the main oil engine is started under the most difficult conditions, for the petrol engine is capable of motoring the oil engine indefinitely.

For cooling the jackets of the main engine and the engine lubricating oil a radiator of liberal proportions, fitted with twelve Serck quickly detachable and interchangeable cooling elements, is mounted on a massive steel frame. Sections of the radiator are used to cool the engine lubricating oil.

The transmission comprises a Vulcan-Sinclair hydraulic coupling followed by a Hunslet patented auxiliary gear-change clutch and a four-speed constant-mesh gear-box, giving locomotive speeds of $5\frac{1}{2}$, $8\frac{1}{2}$, $12\frac{1}{4}$ and $18\frac{1}{2}$ miles an hour. The whole of the control system is that now adopted as standard on all the high-power oil-engined locomotives built by the firm and incorporates the firm's pre-selective gear changing arrangement. A single hand wheel not only controls the engine speed, but also the gears, the actions taking place through a series of cam-operated pneumatic valves, which deliver air at a pressure of 50 lb. per square inch to cylinders controlling gears, clutch and clutch shaft brakes in their correct sequence of operation. The control wheels and all other locomotive controls are duplicated on both sides of the cab, and there is a good "look-out" in either direction from whichever side of the cab the driver may be.

Of built-up plate construction, the gear-box is split on each shaft centre line, thereby simplifying inspection and overhaul. All the spur gears are of helical form, an arrangement of spiral bevel gears being employed for the right-angle drive. Final drive to the wheels is through a jack shaft and coupling rods.

Westinghouse straight air brakes, operating brake blocks on all the wheels, through compensating gear, is provided. Air for their operation is supplied at 100 lb. per square inch pressure by the twin-cylinder Broomwade compressor, shown in the illustration. It is driven from the engine by Thrapston Vulco vee belts.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

VERNIER CALLIPERS AND SLIP GAUGES

(B.S. Nos. 887 and 888).—The specification for Vernier Callipers (No. 887) does not attempt to impose restrictions in regard to details of design but, like the other specifications in the series of Standards for Engineer's Precision Tools, is mainly concerned with prescribing limits of error. It relates to callipers in inch and metric measures in seven standard sizes, the largest of which read up to 48in. and 1 m. respectively. Six types of verniers are described reading to 0·001in. and 0·01 mm. The specification gives permissible errors in the readings over the range of each size of calliper and also prescribes the flatness and straightness of the beam and the flatness and squareness of the measuring jaws. Details are given of the manner in which the graduation shall be engraved, and in an appendix some recommendations are made in regard to the suitable dimensions for the cross sections of the beams. The specification for slip (or block) gauges deals with the parallel-faced type of gauge first introduced by C. E. Johansson and now manufactured in Great Britain. The principal matters dealt with in this specification are the series and sizes of the most frequently used sets, the general dimensions of the gauges, hardness, and accuracy of size. As regards the latter, requirements are laid down for standards of accuracy for three grades of gauges, namely, workshop, inspection, and calibration. The specification also deals with the essential requirements of the accessories commonly used with slip gauges, namely, measuring jaws, scribing and centre points, holders, and bases. An appendix gives helpful information on the care and use of slip gauges in the workshop and test room.

DETERMINATION OF THE FLOW AND DROP POINTS OF FATS AND ALLIED SUBSTANCES

(B.S. 894.)—The British Standards Institution has recently issued a specification for the apparatus and method of use for the determination of the flow and drop point of fats and allied substances. The apparatus is of the Ubbelohde type. The standard thermometer specified is one from Series C of B.S. 593, with certain modifications, the glass cup is specified, also the metal fitting for the thermometer and certain auxiliary apparatus. The method of use is also stated and it is pointed out that the precise method of filling the cup varies with different substances, so that when the use of the apparatus is prescribed for any substance the method of filling with that substance must be defined.

SCREW THREADS OF WHITWORTH FORM

(B.S. 84—1940.)—This new standard is considerably more comprehensive than the previous specifications. It embraces, in one specification, tables of basic sizes and tolerances not only for these two standard series of threads, but also for B.S. pipe (parallel) threads in cases where, on account of their relatively fine pitches, they are used for general engineering purposes as distinct from ordinary pipe joints. Further, the specification is rendered still more comprehensive by providing, for the first time, series of recommended tolerances for all other Whitworth form threads having any reasonable combination of diameter, pitch, and length of engagement. Tables of limits and tolerances are given for the B.S.W., B.S.F., and B.S.P. (parallel) series in three grades of accuracy. These tolerances are on a different basis from those which appeared in the earlier specifications. They have been arrived at from a close study of the accuracy of modern screwing tools and methods coupled with due consideration of the general quality of screw threads now prevailing in the various spheres of engineering production.

Although a new basis has been adopted for the effective diameter tolerances, their actual values are closely comparable with the corresponding tolerances given in the previous B.S. Nos. 84 and 92. This applies also to the new tolerances on the major and minor diameters of the bolts. On the other hand, a substantial increase has now been made in the tolerances for the minor diameters of the nuts, as their former values had been found to be inadequate for general production purposes. The larger tolerances permit of the use of tapping drills of ample size for facilitating tapping and minimising the risk of tap breakage, particularly on the smaller sizes of threads.

Particular attention may be drawn to the general formula now used as a basis for the effective diameter tolerances. Whereas these tolerances had formerly been based solely on the pitch of the thread, the formula now adopted takes account of the diameter of the thread and its length of engagement as well as its pitch. For this reason it has the great advantage of being applicable not only to the standard series of threads such as the B.S.W. and B.S.F., but also to Whitworth form threads in general having any reasonable combination of diameter, pitch, and length of engagement. Tables of tolerances are accordingly provided for such threads.

The appendices to the specification relate to nomenclature and definitions, and give notes in regard to workshop and inspection gauges.

Copies of this specification, No. 84—1940, may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 5s. 4d. post free.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

Export Figures for May

The abbreviated Board of Trade Returns for May show that the total exports of all goods amounted in value to £45,499,645. This was £3,226,295 more than the value of our exports in May, 1939. The exports of coal, valued at £3,423,585, were £422,079 less than in May a year ago. The exports of iron ore and scrap last month were valued at £5978, or £20,497 lower than in May, 1939. There was also a considerable reduction in the exports of non-ferrous metalliferous ores and scrap, which totalled £63,546, or £109,515 less than a year ago. Exports of coke and manufactured fuel, however, showed an increase in value of £16,306 to £362,401. Iron and steel and manufactures thereof were sent abroad to the value of £3,364,547 in May, which was £31,789 less than the value of this material exported in May, 1939. The value of exports of non-ferrous metals and manufactures thereof last month amounted to £1,291,105, a reduction of £142,893 compared with the value in May, 1939. Electrical goods and apparatus exported were valued at £1,477,336, which was an increase of £370,640 on the similar exports in May last year. Exports of machinery totalled in value £3,786,890, or £1,064,784 less than in May, 1939. The value of the exports of vehicles, including locomotives, ships, and aircraft, last May was £3,164,866, a reduction of £736,963 from the value of the corresponding figure for May, 1939.

Our Imports in May

The total imports in May of all kinds of goods reached a value of £105,552,962, a rise of £27,043,668 upon the figure for May, 1939. Imports of non-metalliferous, mining, and quarry products, excluding coal, in May amounted in value to £819,691, an increase of £163,046 compared with the exports in the same month last year. The imports of iron ore and scrap also show an increase over the 1939 figure and rose by £1,019,415 to £1,827,269. The value of the imports of non-metalliferous ores and scrap rose to £2,565,823, an increase of £1,099,086 over the value of the corresponding imports in May last year. The value of iron, steel, and manufactures thereof brought into this country last month amounted to £1,888,749, an increase, when compared with May, 1939, of £468,531. The value of the non-ferrous metals and manufactures thereof imported last month totalled £4,826,700, an advance on the figure for May, 1939, of £1,305,566. On the other hand, the value of electrical goods and apparatus imported dropped by £11,203 to £268,521 last month. Machinery imports increased and at £2,840,500 were £673,930 more than the figure for May, 1939. There was also an increase in the value of the vehicles, including locomotives, ships, and aircraft, which rose to £1,028,389 compared with the figure for May, 1939, indicating an increase in value of £686,273.

The Pig Iron Market

The pressure from consumers anxious to obtain supplies of pig iron is more insistent now than at any time since the commencement of the war. The greatly accelerated output of munitions has resulted in a heavier demand from all classes of consumers engaged in the war effort. With the exception of some of the light castings foundries, nearly all users are engaged upon Government work, and in spite of the larger requirements, the Control, by careful supervision, has been able to keep all the firms employed upon essential production supplied with pig iron. The output of high phosphoric foundry iron is on a smaller scale than during the spring months, as a number of furnaces have been changed over from the production of this quality to the manufacture of basic iron. There is enough of this description, however, to meet the requirements of users, the largest of whom are the light castings founders. Owing to the reduced production, however, there is not very much surplus. The output of low phosphoric qualities is on a good scale, and in spite of the fact that the requirements of the munition makers are continually growing there is no tightness in the supplies of this description. It is hoped, however, that the output will be somewhat increased, in view of the expanding demand. The engineering foundries are now working without cessation, and their requirements are rising daily. Some of the hematite producers have stocks upon which they can draw to meet consumers' needs, but in most cases the reserves which they possessed a few weeks ago have been liquidated. Production continues at a high level, and is increasing, as is also the demand, particularly from the engineering consumers. Output is already pressed to the utmost, but under the new impulse and in order to expand the production of munitions, efforts are being made to bring additional plant into operation. The amount of new business passing is not large, since it is difficult to place orders for near delivery, and there is little likelihood of far forward selling being resumed by the makers. On the North-East Coast the production of hematite is on a large scale, but the greater part of it is required by the associated steel works. The call for basic iron from the steel works is insistent, and is being met effectively by the Control. Considerable imports have reached this country, and attempts have been made to increase the home production, in view of the greatly increased demand resulting from the munitions drive.

The Midlands and South Wales

In the Midland area the iron and steel industry has achieved considerable success in increasing outputs. Practically the whole of the industry is now devoted to work of national importance, and much of this is of an urgent character. As a consequence, work which has been on the books for some time, but which is not so essential, is being relegated to the background. Consumers are realising the necessity of fitting in their arrangements with the needs of the times, and are supporting the authorities in the big munitions drive. There has been no relief from the demands upon the heavy steel makers for structural material of all descriptions. There is a heavy request for joists, and lately the demand for bars of all sizes has been particularly noticeable. It has been difficult for some time to place orders for plates, and the situation now appears to have become tighter. This is due to the necessity of giving preference to material required for urgent jobs. The Control has the position well in hand, and is keeping the steel trade carefully instructed as to the kinds of steel to be made, and how it has to be distributed. Structural steel is being produced in large tonnages, which are immediately absorbed, and greater quantities could be utilised as a result of the big programme of factory construction and works extensions which is being undertaken. The boilermakers, locomotive builders, and the tank makers are all busily engaged, and are requiring large tonnages of plates. The stringency noticeable in this section of the market is no new development, but if it were not for the skilful distribution of supplies arranged by the Control, it is possible that the situation might become difficult. The re-rollers have contracts on their books sufficient to keep them employed for some months. So far the loss of supplies of semis from Belgium and Luxemburg has not affected the industry, owing to the good stocks which had been accumulated previous to the invasion of those countries. Arrangements for the importation of semis from the Western hemisphere are understood to have been made, and it is reported that already some shipments have reached this side. In South Wales the situation has improved to some extent, owing to the better supplies of raw materials for steel making. There is still, however, some tightness in the market, and the demands of the tin-plate works are not being fully met. Lately there has been some recession in the export requirements, which is partially due to the number of countries over-run by the Germans. It is thought that the excessive demands of the Services for steel in other forms may result in some cutting down in supplies to the tin-plate trade. In the home market busy conditions continue to rule, and practically all the business transacted is in connection with Service requirements.

Scotland and the North

The Scottish steel works are playing their part to the full in the drive to achieve larger outputs. The raw material position is satisfactory, and although the demand for scrap is excessive, the success of the home efforts to stimulate collection has helped to improve the position, which is further strengthened by the arrival of considerable quantities from the United States. The output of steel therefore now seems to be established at record levels. The demand, however, is sufficient immediately to absorb every ton produced, and there is no doubt that under the present conditions many old orders will have to be carried forward into a further period, owing to the urgency of so much of the work now being sent to the trade. Ordinary consumers find great difficulty in placing their business, since practically the whole of the output for the time being is devoted to Service requirements. The constructional engineers in Scotland have large contracts in hand, and are providing an outlet for enormous tonnages of bars, angles, joists, and sections. Owing to the large amount of work now in hand, it is probable that the requirements will be maintained at their present rate for some time. The call for bars, large and small, has been particularly insistent of late, and big tonnages have been manufactured and have passed into consumption. Other branches of the consuming trades in Scotland are equally busy. The shipyards, of course, are working without interruption and are taking up astonishing tonnages of plates and other shipbuilding steel. The Admiralty programme of naval and merchant ships is in full swing, and although there has been some talk of a possibility of a slackening off in the construction of some kinds of vessels, this does not so far make any perceptible difference to the demand upon the steel works. The Scottish re-rollers are well placed for supplies of semis, and their production of small bars and sections is on a satisfactory scale. The demand, however, is in excess of the capacity of the works, and some delay in deliveries is no more than to be expected. In the Lancashire district all the consuming industries which are employed upon war work are operating at full capacity in the national service. There is an insatiable demand for practically all kinds of steel. The products of the heavy steel works are going steadily into consumption, and there is an increasing demand for wire and wire products. The request for alloy and special steels has also assumed large proportions, and the position in this department shows some signs of stringency. On the North-West Coast the armament drive is providing a tremendous amount of work, and, in addition, there is a good output of hoops, a good part of which is being devoted to the export trade.

Copper and Tin

Conditions in the copper market have not changed much, in spite of the sensational war developments. It is understood that the British Government will take over the French copper contracts with American producers in cases in which the price was definitely fixed. The French Government placed some big orders in the United States, including one for 25,000 tons of copper per month for the duration of the war, but in this case the price was at the figure ruling at date of shipment, and it is possible that this contract will lapse. A recent contract for 75,000 tons may be taken over, as the price is understood to have been agreed upon. It has been assumed that the British requirements could be very largely met by the Empire producers, but since the big munition drive some purchases have been made by Great Britain of American electrolytic copper, it being understood that the Empire refinery capacity was not sufficient to give this country all the copper it wanted in the stipulated time. Following the collapse of French resistance, the copper market in the United States became somewhat weaker and the price dropped from 11·50c. f.a.s. to 11·10c., and this has been shaded. The French had also ordered a considerable amount of copper in partly finished and finished form, and it is suggested that these contracts will now be cancelled. There are reports that considerable quantities of copper destined for France, Italy and Switzerland have been stopped at Gibraltar by the British Contraband Control. The burst of buying by American consumers has faded away, and there seems to be a rather nervous tone in the American market. In Great Britain the situation so far as supplies are concerned is quite comfortable. Practically all consumers are engaged on war work and the consumption of the metal is on a large scale; there is, however, no likelihood of any shortage developing. . . . Following the sharp upward movement in the tin market prices dropped on news of the French *débâcle*, and American consumers who had been buying somewhat recklessly withdrew from the market for a time. The situation is somewhat difficult because the delivery of all tin sold to France by Great Britain has been stopped. The news of the latest war development had the effect of shaking confidence in the East so severely that prices fell by over £27. This collapse was regarded somewhat seriously by the authorities, and the establishment of maximum and minimum prices on the London Metal Exchange was considered; the market, however, developed a steadier tone afterwards, and no steps were taken in this direction. In this country supplies of tin appear to be quite sufficient to meet all war requirements, and it should be remembered that tin is a metal which is less affected than most of the non-ferrous metals by the war demand.

Lead and Spelter

Although the consumption of lead is on a very considerable scale and has increased lately as a result of the munitions drive, there is no question of any shortage. Consumers are obtaining their requirements steadily and supplies appear to be reaching this country with regularity. Orders which France had placed in the United States for lead have been held up. The active buying by American domestic consumers appears to have become quieter, but the price has held and the producers are reported to be in a good position as regards orders in hand. There is some speculation as to the result of the collapse of the French resistance upon the Mexican situation. Apparently the whole of the production of Mexico now becomes available, but the world's markets are severely limited by the war and producers in that country are not in an enviable position. . . . The position of consumers of spelter in this country is comfortable, since supplies continue to arrive with regularity and there have been no reports of users having to go short of the metal. Large purchases of prompt spelter had been made by the Allied Purchasing Committee in the United States before the French sued for peace, and there is some doubt as to how these contracts will be dealt with. It is expected, however, that Great Britain will take over the contracts in cases in which the price was agreed, and that the metal will be brought to this country. Before the French collapse it was thought that the British Empire producers would be able to supply this country with all the spelter she was likely to require even for the war effort, but presumably the American purchases will make the position here more secure. In this country consumption has been at a very high rate, and for the most part supplies have consisted of high-grade metal. In the United States the market remains steady and apparently the producers are in a sound position.

BOOKS RECEIVED

Hoisting Machinery. By W. H. Atherton, M.Sc. London: Technical Press, Ltd., 5, Ave Maria Lane, E.C.4. Price 32s. 6d. net.

Household Physics. Third Edition. By W. G. Whitman. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 18s. net.

The Colliery Year Book and Coal Trades Directory, 1940. London: Louis Cassier Company, Ltd., 22, Henrietta Street, W.C.2. Price 21s. net.

Tests on the Liquefaction of Canadian Coals by Hydrogenation. By T. E. Warren and K. W. Bowles. Ottawa: Bureau of Mines. Price 25 cents net.

B.E.A. Classified Handbook of Members and Their Manufactures, 1940. London: The British Engineers' Association, 32, Victoria Street, S.W.1.

Non-Ferrous Foundry Practice. By J. Laing and R. T. Rolfe. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 21s. net.

Writing the Technical Report. By J. R. Nelson. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 16s. 6d. net.

Photo-Electric and Selenium Cells. Second Edition. By T. J. Fielding. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 7s. 6d. net.

Religion in Science and Civilisation. By Sir Richard Gregory, Bart., F.R.S. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 12s. 6d. net.

Johnson's Materials of Construction. Eighth Edition. By M. O. Withey and J. Aston. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 36s. net.

Steam, Gas and Air Power. Third Edition. By W. H. Severns and H. E. Degler. London: Chapman and Hall. Ltd., 11, Henrietta Street, W.C.2. Price 24s. net.

Mathematical Methods in Engineering. By T. v. Karman and M. A. Biot. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 26s. net.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

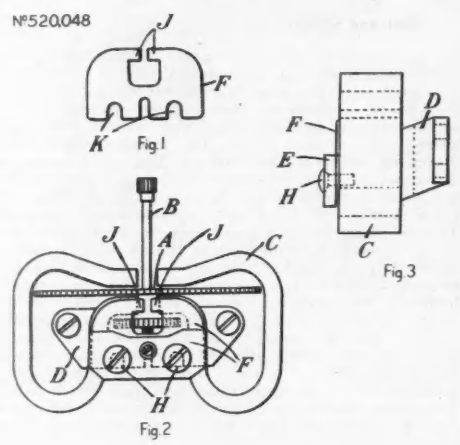
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

MEASURING AND TESTING INSTRUMENTS

520,048. October 17th, 1938.—ELECTRIC MEASURING INSTRUMENTS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2, George Tilstone and John Francis Donelly, both of Siemens Works, Stafford.

Changes of temperature by changing the magnetic properties of the magnetic cores of electrical measuring instruments are liable to affect the accuracy of an instrument. According to this invention a temperature compensating magnetic shunt having the necessary temperature coefficient of permeability is adapted to provide a shunt path for magnetic flux between two chosen points on the core. No special fixing means for the shunt are necessary. Of the accompanying drawings, Fig. 1 shows a shunt according to the invention suitable for use on the permanent braking magnet of an induction type watthour-meter as shown in elevation in Fig. 2 and end view in Fig. 3. The driving cores (not shown) usually embrace the meter disc A at the back of the case behind the spindle B while the permanent braking magnets C embrace the edge of the disc A in front of the spindle B, the permanent magnets C being mounted on the front of a supporting bracket D the back of which carries the driving cores. Figs. 2 and 3 show a common method of fixing the permanent magnets in which the back edges of parts of the core limbs rest on a part of this bracket B and are clamped tightly thereto by a non-magnetic clamp plate E secured to the

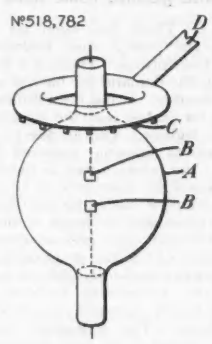


bracket D by screws H and bearing on the front edges of these same parts of the core limbs. In applying the invention a flat piece of plate F of the appropriate magnetic material is provided, as shown in the detail view, Fig 1, with holes or slots K of the right size and pitch to fit the two screws H. This plate F is placed under the fixing clamp E on the front of the core C so as to extend between the two core limbs transversely to the screws H, which pass through the slots K. The clamp thus holds the plate F in position when the screws are tightened up. The plate has two horns J separated by a short air gap. These lie along and overlap the edges of the air gap between the lower core limbs when the plate is in position. Thus these horns are positioned in the maximum leakage field and most of the flux shunted across the gap between the cores will go by way of the horns and the gap between them so that this part of the plate forms the shunt proper. The width of the horns and the gap between them will be proportioned, according to the temperature characteristics of the magnet and the temperature coefficient of permeability of the material of the plate F, to give the corrective characteristic desired. Since no special shaping of the cores C is necessary such a shunt as shown at F and of appropriate dimensions can readily be added to existing meters of many designs, it being necessary only to slacken or remove the screws H and to slip the shunt F into place under the clamp E.—*April 12th*, 1940.

LIGHTING AND HEATING

518,782. September 2nd, 1938.—HIGH-PRESSURE METAL-VAPOUR ELECTRIC DISCHARGE LAMPS, the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Victor James Francis and Eric Kettlewell, and Karl Gustav Schnetzler, all of Research Laboratories of the General Electric Company, Ltd., Wembley, Middlesex.

This invention concerns apparatus for producing light of the type wherein the source of light is a high-pressure metal-vapour electric discharge lamp having an approximately spherical envelope and adapted in full operation to dissipate within the envelope at least 1 kW. The embodiment of the invention is illustrated. A is an approximately spherical quartz envelope 40 mm. in external diameter, so that the area of its surface is about 50 square cm. B B are the running electrodes separated by 10 mm. Starting electrodes are associated with the running electrodes, but they are irrelevant to the invention and are therefore not shown. The electrodes are connected to a circuit (not shown) whereby in full operation the R.M.S. voltage between the electrodes is some 70 volts and the R.M.S. current some 65 amp, so that the power dissipated in the discharge is some 4000 watts. Eighteen tubes C, each of 1 mm. bore, are directed

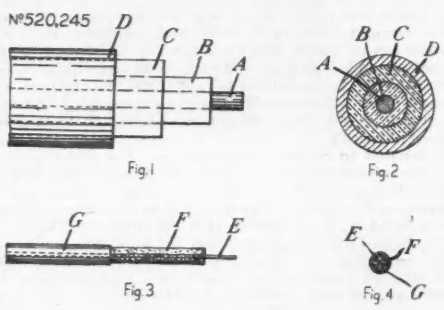


from above at the surface of the envelope, the distance between the end of each tube and the envelope being some 15 mm. Air from a common inlet is forced to pass down each of these tubes at the rate of some 5 litres per minute. The lamp will then operate satisfactorily for long periods without any deterioration of the envelope.—*March 7th*, 1940.

MISCELLANEOUS

520,245. October 15th, 1938.—INSULATED ELECTRIC CONDUCTORS, British Insulated Cables, Ltd., of Prescot, Francis Joseph Brislee, of "Wayside," Rupert Road, Huyton, Lancashire, Leonard Charles Bannister, of Howards Lane, Eccleston, St. Helens, Lancashire, Laurence Macfarlane, of "Lorelan," Alder Road, Prescot, Lancashire, Michael Lister Butler Gould, of "Ashfield," St. Mary's Road, Huyton, Lancashire and Leonard Rolls Bowness Spence, of "Stalisfield," Archway Road, Huyton, Lancashire.

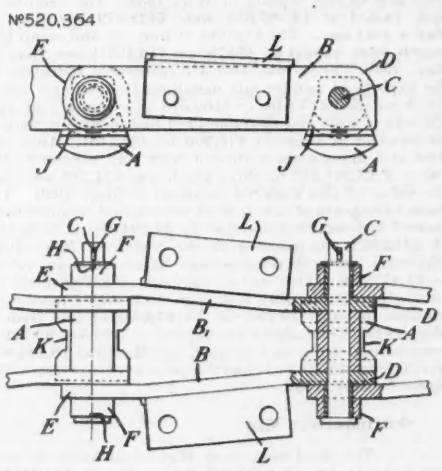
The invention is concerned with the production of an insulated conductor comprising the conductor itself, a metal tube surrounding it and refractory powdered material such as glass between the conductor and the tube, the manufacture being carried out by a process of elongation by rolling or drawing down the conductor, tube and refractory material as a whole. In the present case the refractory material is glass. It has been found that it is not necessary, in producing an insulated conductor for ordinary electricity distributing purposes, to have adherence between the conductor and the glass and that satisfactory operation and results can be obtained, provided that both conductor and tube are of copper. In accordance with the invention, use is made of a copper rod, a glass tube which slides over the rod, and a copper tube which slides over the glass tube.



These parts are assembled together and then elongated by drawing or rolling down, accompanied by suitable annealing between the stages of elongation. It is advantageous, particularly when using a large radial thickness of glass, to apply the glass in the initial assembly as two or more co-axial tubes fitting together. It is also advantageous, but not essential, to heat the assembly, before commencing to draw, to a suitable temperature to anneal the copper, and then to chill it rapidly. This causes the glass to crack throughout thereby facilitating the early stages of the elongating operation, in which the glass is reduced to powder. A temperature of 450 deg. Cent. to 650 deg. Cent. is sufficient, both for annealing and for cracking the glass on chilling. Before the heating the spaces between the copper tube and the glass tube and between the glass tube and conductor are preferably filled with an inert gas, for instance, carbon dioxide or nitrogen, and the annealing should be carried out in an inert atmosphere to prevent oxidation or other contamination of the metal. Figs. 1 and 2 show the initial assembly in elevation and cross-section and Figs. 3 and 4 the finished conductor. Referring to Figs. 1 and 2, a copper rod A is enclosed in co-axial glass tubes B and C and an outer copper tube D. Figs. 3 and 4 show how this assembly is reduced in diameter by the rolling or drawing operations to produce the conductor E and sheath G separated by powdered glass insulation F.—*April 18th*, 1940.

520,364. January 24th, 1939.—IMPROVEMENTS IN CHAIN BELTS, William Rhodes Ward, and J. Dawson Fawcett (Darlington), Ltd., both of Haughton Engineering Works, Darlington.

One form of chain belt constructed in accordance with this invention is illustrated in the accompanying drawings. A block A is disposed at each joint of the links, each of which is preferably formed in two portions B, B, disposed one at each end of the block at a joint. A joint pin C passes through the block and the ends of the two links. The ends D D of the two portions of one link at a joint are disposed immediately adjacent the ends of the block, and the ends E E of the other link are disposed outside of these ends. Preferably, the inner link at one joint is adapted to become the outer link at the next joint, and to effect this the link plates are cranked. Bosses F are formed on the outer faces of the outer links and one end of the joint pin is provided with a head, a cotter G being passed through the other end. Bearings for the joint pin may be disposed in the bosses, both of which are secured against relative rotary



movement by projections H in the bosses engaging slots in the bearings. Each end of the block is provided with a stop or shoulder J and the two ends of the inner link are each provided on an edge with a face adapted to engage the shoulders so that they act as stops to prevent rotary movement of the block relative to the inner link. The blocks may be grooved circumferentially at K as illustrated, as to engage a ribbed pulley, or they may be ribbed circumferentially so as to engage a grooved pulley. In use the blocks are retained in their operating positions by the inner links at the joints and prevented from swinging round on the joint pin when they engage the pulley frictionally. The links of the chain belt may be provided medially of their ends with flanges L or other devices by which buckets or other devices may be secured.—*April 22nd*, 1940.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Civil Engineers

Wednesday, July 3rd.—N.W. Assoc.: College of Technology, Manchester. "Recent Developments in Air Raid Precautions," R. E. Bowles. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

C. H. MOUNTFORD, 68, Nechells Park Road, Birmingham, 7, has been appointed the sole Midland agent and representative for the Taylor Stoker Company, Ltd., of London.

THE INSTITUTION OF AUTOMOBILE ENGINEERS informs us that Mr. C. G. Williams, Director of Research, is transferring his services to another research organisation in September next, and Dr. E. Giffen (King's College, London) has been appointed as his successor.

CATALOGUES

BRAITHWAITE AND CO., Engineers, Ltd., Horseferry House, London, S.W.1.—Illustrated catalogue of pressed steel tanks.

BRISTOL'S INSTRUMENT COMPANY, Ltd., Brent Crescent, West Twyford, N.W.10.—Bulletin E 100, on the "Pyromaster" potentiometer.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria Street, E.C.4.—Publication 1160 on the "Ter Linden" cyclone dust collector.

CROSSLEY BROTHERS, Ltd., Manchester.—A loose-leaf binder containing details of a large number of marine oil engine installations carried out by the company.

CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 232, Dawes Road, S.W.6.—New general catalogue covering the wide range of pneumatic tools which the company makes.

END OF VOL. CLXIX

The Engineer

LONDON, FRIDAY, JUNE 28, 1940.

PUBLIC NOTICES

AIR MINISTRY

CIVILIAN INSTRUCTORS REQUIRED

Vacancies exist for CIVILIAN FITTER AIRFRAME INSTRUCTORS at an initial rate of pay of £4 5s. a week inclusive, increasing to £4 10s. a week on the satisfactory completion of a probationary period, and thereafter by annual increments of 2s. 6d. per week to £5 per week.

The necessary qualifications are:—

Fitter Airframe Instructors must have a good knowledge of airframe component construction and a knowledge of rigging and principles of flight. Knowledge and treatment of materials used in airframe construction are also required.

Successful candidates may be required to undergo a short course of training during the early stages of their employment to fit them for their duties as instructors.

Vacancies also occur for selected applicants with a theoretical or practical knowledge of an allied trade to the aircraft industry who are capable, after a course of instruction, of qualifying as Fitter Airframe Instructors.

Applications should be addressed, in writing only, to the UNDER-SECRETARY OF STATE, AIR MINISTRY (S.5.d), KINGSWAY, LONDON, W.C.2, giving particulars as to previous experience, age, &c. Suitable candidates, who must be over 30 years of age, will then be required to attend at the nearest Royal Air Force trade testing centre for the necessary trade test and medical examination, but may be re-imbursed the cost of third-class locomotion expenses for this purpose. 9764

UNIVERSITY COLLEGE OF SWANSEA

APPLIED SCIENCE DEPARTMENTS

University College of Swansea.
(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF WALES.)

Principal: C. A. EDWARDS, D.Sc., F.R.S.

APPLIED SCIENCE DEPARTMENTS

ENGINEERING

Professor: FREDERIC BACON, M.A. (Cantab.), A.M. Inst. C.E., M.I. Mech. E., M.I.E.E.
Lecturer in Electrical Engineering: R. G. ISAACS, M.Sc. (Bristol), B.Sc. (Lond.), A.M.I.E.E.
Lecturer in Civil Engineering: A. A. FORDHAM, Ph.D. (Lond.), A.M. Inst. C.E., M.I. Struct. E.
Lecturer: J. SELWYN CASWELL, M.Sc. (Wales), A.M.I. Mech. E., A.M. Inst. C.E.
Assistant Lecturer: W. E. J. FARVIS, B.Sc. (Bristol).

METALLURGY

Professor: Vacant.
Lecturers: R. HIGGINS, Ph.D. (Glasgow), R. GRIFFITHS, M.Sc. (Wales).
Assistant Lecturer: T. B. WILKINSON, Ph.D., B.Eng. (Liverpool).

The College offers a number of exceptional advantages to students who aim at entering upon professional careers in Engineering or in Metallurgy. It is situated in the heart of an industrial area which includes a large number of works of very varied character and presents an unrivalled variety of metallurgical practice. The Manufacturers of the district, who contribute largely to the support of the College, give the Staff and Students of the Applied Science Departments every access to the Works, and the Managers, Engineers, and Technical Officials co-operate with the Staff of the College in making visits to Works of practical educational value to the Students.

Courses of study are provided (1) for the B.Sc. Degree of the University of Wales in (a) Civil Engineering, (b) Mechanical Engineering, (c) Electrical Engineering, (d) Metallurgical Engineering, (e) Metallurgy; and (2) for Diplomas of the College in (a) Civil Engineering, (b) Mechanical Engineering, (c) Electrical Engineering, (d) Metallurgy.

Persons who are not desirous of studying for Degrees or Diplomas may attend selected College classes, provided they satisfy the authorities of the College that they are qualified to benefit by such classes.

Entrance Scholarships will be offered for competition in April, 1941.

Particulars concerning admission to the College, and of the Entrance Scholarships, may be obtained from the undersigned.

EDWIN DREW,
Registrar.

Singleton Park,
Swansea. 6258

CITY AND ROYAL BOROUGH OF DUNDEE

ASSISTANT TO STATION ENGINEER

Applications are Invited for the above APPOINTMENT from experienced engineers of an age preferably not over 40, at a salary in accordance with the National Joint Board Schedule, Class G, Grade 6, at present £431 per annum. A 30,000-kW Extension is nearing completion.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the selected candidate will be required to pass a medical examination.

Applicants must have a sound theoretical knowledge and considerable practical training and experience in the operation and maintenance of large modern High-pressure Boilers, Fuel and Ash-handling Plant, Turbo-alternators, and their associated auxiliaries. The successful candidate will be required to Take Charge of all Overhauls and Repairs, and must have the initiative and resource necessary for organising and expeditiously carrying out such work and for dealing promptly with emergencies, as well as boiler and turbo-alternator efficiency tests. A thorough knowledge of the principles of fuel combustion and steam generation is also essential, and he would also be expected to assist the Generation Engineer in any special matters relating to the running of the station.

Applications, stating age, full particulars of theoretical and mechanical training, experience, and qualifications, and accompanied by copies of recent testimonials, should be forwarded to the undersigned not later than 11th July, 1940.

D. H. BISHOP, B.Sc., M.I.E.E.,
General Manager and Engineer.

Dudhope Crescent Road,
Dundee.
24th June, 1940. 6264

The Engineer

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IMPORTANT NOTICE.

"THE ENGINEER" is again being printed in London and published from the offices of

THE ENGINEER,
28, ESSEX STREET,
STRAND, LONDON, W.C.2.

All communications should therefore be sent to this address.

PUBLIC NOTICES

WEST CHESHIRE WATER BOARD

PRENTON PUMPING STATION

Tenders are Invited for the TESTING of a BORE-HOLE at the above Station situated in Prenton, near Birkenhead, Cheshire, and the subsequent DRIVING of an ADIT in Triassic Sandstone at a depth of about 250ft. below ground level and about 60 yards long.

Specification and form of Tender may be obtained from the undersigned.

Sealed Tenders, endorsed "Tender for Test Pumping," must be delivered to the "Chairman of the Board," at the undernoted address, not later than Noon on Wednesday, July 10th, 1940.

The Board do not bind themselves to accept the lowest or any Tender.

C. HARDMAN, A.M.I.C.E., A.M.I.M.E.,
Engineer to the Board.

Water Board Buildings,
11-15, Cross Street,
Birkenhead,
25th June, 1940. 6267

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

PUBLIC NOTICES

CITY OF SALFORD

ROYAL TECHNICAL COLLEGE, SALFORD

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Wanted, Two Instructors.

Candidates must have served a Regular Apprenticeship in Mechanical Engineering, and should be familiar with both New and Old Types of Centre Lathes. Teaching Experience is desirable.

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Forms of application may be obtained from the Acting Director of Education, Education Office, Chapel Street, Salford, 3, Lancs, and should be returned immediately.

H. H. TOMSON,
6228 Town Clerk.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, for London, by Firm of Mill Furnishers of old standing, an ENGINEER REPRESENTATIVE of experience, able to Estimate and Supervise Execution of Contracts; remuneration, salary and commission.—Write, stating age, experience, and salary required, to Box 4525, Frost-Smith Advg., 64, Finsbury Pavement, E.C.2. 6266 A

SITUATIONS OPEN

ASSISTANT BUYER and ESTIMATOR REQUIRED by well-known Firm of Contracting Gas Engineers in the South. Good salary and prospects to the right man.—Address, in strict confidence, stating full particulars of training and experience, 6269, The Engineer Office, 28, Essex Street, London, W.C.2. 6269 A

CONEX TERNA, Limited, Whitehall Road, Great Bridge, Staffs.—MANAGER REQUIRED to take Complete Control. First-class Engineering and Commercial Knowledge essential. Salary and bonus. Mark envelope "Manager" top L.H. corner. P2675 A

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ENGINEER-SURVEYOR, Aged 30 Years, REQUIRED by Engineering Dept. of an Insurance Company. Applicants must be prepared to reside in or near Bristol, be practical engineers with technical experience, and hold a First or Extra-First-Class Board of Trade Certificate. Electrical experience advantageous, and must be capable of writing clear reports and making accurately dimensioned drawings of all classes of machinery. Commencing salary £260 per annum.—Apply in own handwriting to "D.A.," c/o Charles Barker and Sons, Ltd., 31, Budge Row, E.C.4. 9933 A

INSPECTORS experienced in Aircraft work REQUIRED by firm in West of Scotland engaged on Air Frames and Fuselage construction. Reply, stating full particulars and wage expected, to 6131, The Engineer Office, 28, Essex Street, London, W.C.2. 6131 A

PUMP MANUFACTURERS REQUIRE Experienced MAN to handle Home and Export Tenders, Orders, and Sales Correspondence. State age, salary required, and full details experience.—Address, 6268, The Engineer Office, 28, Essex Street, London, W.C.2. 6268 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

FOREMAN REQUIRED for Large Engineering Assembly Shop. Must be good Organiser and have General Engineering knowledge; particular knowledge of product not essential. Midlands area.—Address, 6230, The Engineer Office, 28, Essex Street, London, W.C.2. 6230 A

FOREMAN REQUIRED by Firm in the West of Scotland engaged on Metal Aircraft Fuselage Construction. Applicants must have had previous experience of this type of work.—Address, stating full particulars and wage expected, 6130, The Engineer Office, 28, Essex Street, London, W.C.2. 6130 A

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A.M. INST. C.E., A.M.I. Mech. E. (49), Railway locomotive works, D.O., running shed training, wide experience public works and general engineering; at present chief engineer large municipal transport system, electric traction and I.C. and C.I engines, capable organiser, inventive, and energetic, DESIRES CHANGE.—Address, P2677, The Engineer Office, 28, Essex Street, London, W.C.2. P2677 B

CIVIL and MECHANICAL ENGINEER, over military age. Very extensive experience in all construction work, steel, brick and concrete buildings, bridge and railroad work, road and sewage, installation of machinery, pile driving and dock work. Beside commercial, has also had Government contract experience, and is prepared to go abroad if required. Has had complete control of very large contracts at home and abroad. Can carry through the whole of the administration work, and is free to take up an appointment at once.—Address, P2676, The Engineer Office, 28, Essex Street, London, W.C.2. P2676 B

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer

Annual Subscription Rates

(including postal charges).

BRITISH ISLES ...	£3	5	0	
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ABROAD	£3	7	6	Thick Paper Ed.
(except Canada)	£3	3	0	Thin Paper Ed.

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, August 30th.

ADVERTISEMENTS.

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

ostal Address, 28, Essex-street, Strand, London, W.C.2. Teleg. Address, "Engineer Newspaper, Estrand, London." Tel. Central 6565 (10 lines).

SITUATIONS WANTED

EXPERIENCED ENGINEER and GENERAL MANAGER, now at liberty, SEEKS ADMINISTRATIVE POSITION. Wide experience of responsible work.—Address, P2668, The Engineer Office, 28, Essex Street, London, W.C.2. P2668 B

IF the Man You are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time and Waste of Opportunity. The charge is Four Lines or under 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

MECHANICAL ENGINEER (30, Dutch, 5½ Years in England) DESIRES EXECUTIVE POSITION. Engineering Degree with Honour. Sound training in drawing office, workshops, and laboratories. Practical experience in designing, planning, and carrying out of work. Good technical insight, ambitious.—Address, P2679, The Engineer Office, 28, Essex Street, London, W.C.2. P2679 B

MR. WALLACE A. D. HARDING, M.I.C.E., M.I. Mech. E., M.I.L.E., late Chief Mechanical Engineer of the Rio-Tinto Company, Limited, has retired from active service in Spain, and OFFERS HIS SERVICES as WORKS or ASSISTANT MANAGER, or as CONSULTANT, or in an ADVISORY CAPACITY to Boards, Committees, or Managements. Inspection of Plant or Machinery during manufacture or after erection. He has 40 years' experience over a wide range of Works Management and of Constructional and Mechanical Work, including Railways, Road Transport, Mines Machinery, and General Engineering.—For further information apply to the above at 50, Whitecross Street, London, E.C.3. 6263 B

AGENCIES

EXPERIENCED ENGINEER SALESMAN or BUYING AGENT REQUIRES AGENCIES or REPRESENTATIONS. London Office available.—Write, MELLOWS, 93, Turnmill St., E.C.1. P2674 D

SUB-CONTRACTING WANTED

GOVERNMENT Defence Contracts: Leeds Engineering Firm with Machine, Erecting, Plating, Structural, and Welding Shops, SOLICIT SUB-CONTRACTS.—H. E. MARSDEN, Ltd., Soho Engineering Works, Leeds, 11. 9991 MW

MISCELLANEOUS

CAPITAL.—ADVERTISER, Having Procured from £3000 to £40,000 for many Private Companies, proofs available, WANTS DIRECTORSHIPS for CLIENTS with £2000 to £10,000.—Write, Box 355, at Horncastle's, 103, Cheapside, London, E.C.2. 6265 I

GOVERNMENT COMPENSATION SCHEME of ASSESSMENT of DAMAGE NECESSITATES a VALUATION OF ASSETS. Particulars of LEOPOLD FARMER and SONS, Surveyors and Valuers of Factories, Plant and Machinery, 46, Gresham Street, E.C.2. 6256 I

HANDELSVEREENIGING "AMSTERDAM" Will any FIRM having CONTRACTED to SUPPLY MACHINERY, SPARE PARTS, &c., to H. V. A. Dutch E.1, please COMMUNICATE with London Representative, R. R. BENNINK, 21, Mincing Lane, London, E.C.3. 6253 I

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PRECISION MACHINERY
for any purpose designed and built in our own factory. Please send enquiries to
HENRY MILNES LIMITED, Machine Tool Works
Ingleby Street, BRADFORD, Yorks.

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THE DAVIDSON ROTARY RETORT.
A second Battery of these Retorts has been installed by the New Consolidated Gold Fields Ltd.
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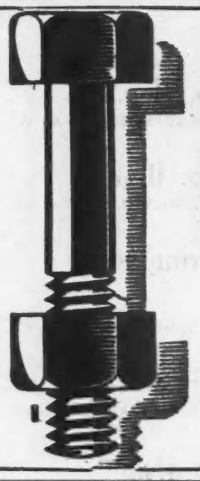
See Advt.—"Engineer"—May 3



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VICTOR DIESEL
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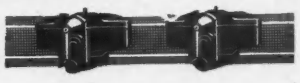

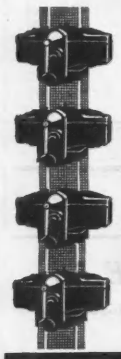

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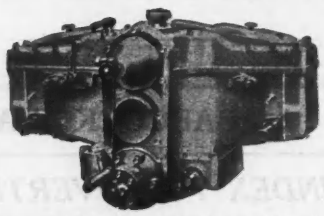

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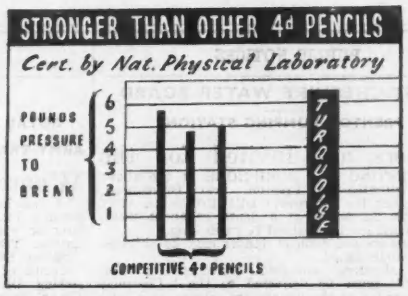
Every delay in the execution of Government commissions means a delay in ending the war. Every minute lost by sharpening a pencil is a minute lost to the enemy. To save time, money and unnecessary inconvenience, more and more draughtsmen all over the country are specifying "Chemi-Sealed" TURQUOISE pencils. For the points of "Chemi-Sealed" TURQUOISE pencils are *so strong that they cannot be broken in normal use.* Please write for sample set, stating degrees (6B to 9H) required.



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MADE IN ENGLAND BY EAGLE PENCIL COMPANY, LONDON, N. 17.
Proprietors of British Regd. Trade Mark "Chemi-Sealed"

COMPANY MEETING

PETER BROTHERHOOD LIMITED

SATISFACTORY CASH POSITION

DISTRIBUTION OF 20 PER CENT.

INCREASED VOLUME OF WORK

MR. A. M. NEAL'S ADDRESS

THE Thirty-third Ordinary General Meeting of Peter Brotherhood Limited was held yesterday at Winchester House, Old Broad Street, London, E.C.2.

Mr. Alexander Marcus Neal, A.M.I.C.E. (Chairman of the Company), presided.

The Secretary (Mr. J. Gerrard) having read the Notice convening the meeting and the Report of the Auditors,

The CHAIRMAN said: Gentlemen, my first duty as Chairman is, I think, to refer to the recent death of one of our Directors, Mr. Alan Hubert Carnt, whose name appears on the Directors' Report, which is in your hands, but who has unfortunately died since this was printed, as a result of a motor accident on June 13th, while returning home from a business journey on behalf of the firm. All his colleagues on the Board, and all the other people who knew him, will miss his help and comradeship, and I would ask you, if you will, to stand for just one moment in respect to his memory.

The meeting then stood in silence.

The CHAIRMAN: Thank you. I would like also to apologise for the absence of Mr. F. H. Davis, one of the Directors, who is remaining at the works in order that all the Directors should not be absent at the same time.

As the Directors' Report and Statement of Accounts have already been circulated, may I assume that you will agree to take them as read? ("Agreed.") Thank you.

Now I should like, gentlemen, to make a few remarks on the Balance Sheet and Accounts which have been circulated. If you will kindly refer to the Balance Sheet—on the Assets side—the first item, cash at bank and in hand, stands at £127,674 (quoting to the nearest pound), and shows an increase of £8389 on last year's figure. In view of the expansion of our business during the year and the large payments we have necessarily had to make for materials for contracts now in hand, I think you will agree that the cash position at the 31st March was quite satisfactory. The next item, Sundry Debtors, shows an increase of £10,450, whilst Stock in Hand and Work in Progress—the next item—stands at £498,284, against £344,445 last year. Both of these increases are, of course, attributable to the considerably increased amount of work carried out during the year and at present in hand.

PLANT FULLY UP TO DATE

Fixed Plant and Machinery stands at much the same figure, namely, some £137,000, indicating that the purchase of new machine tools during the year, amounting to £21,011, is, to a great extent, offset by the normal depreciation for the year of £10,361, plus the special depreciation of £10,000, which you were good enough to confirm at our meeting last year. I need hardly emphasise that this question of machine tools is one which is constantly in the minds of your Directors, and that increased output has demanded, and will continue to demand, considerable expenditure in plant and machinery. Your Directors are satisfied that at the moment the plant is fully up to date and capable of dealing with any demands which may be made upon it.

The other items on the Assets side do not call for special comment, with the exception perhaps of the last item, Air Raid Precautions Suspense Account, at £12,275. Towards this you are to-day, as you will note from the Directors' Report, asked to agree to set aside the sum of £7500 as last year, which, with the £5000 we expect to recover from the Government, will liquidate this item from the Balance Sheet.

INCREASED TAXATION

On the Liabilities side of the Balance Sheet, the increase in sundry creditors of £34,175 reflects again the increased amount of work being carried out, but provision for taxation at £70,730, against £23,228 last year, is a reminder of the extent to which it is the duty of us all to place our strength and substance at the service of the Government.

The next item, General Reserve, remains at £50,000, but, as you will see from the Directors' Report, we propose to ask you to sanction the setting aside of £10,000, as last year, for special depreciation of machine tools and machinery generally.

PROFIT AND DIVIDEND

Turning to the Profit and Loss Account, the net profit for the year, before providing for Income Tax and Excess Profits Tax, is £139,050, against a figure last year of £98,174, but the Income Tax and Excess Profits Tax reduce the amount of profit made during the year and available for distribution and other purposes to £75,550, against £81,924 last year. In view of the prevailing conditions of uncertainty, of the necessity to conserve the Company's resources, and of the impending increase in the rate of Excess Profits Tax from 60 per cent. to 100 per cent., your Board, after careful consideration and after taking the advice of their financial adviser, Mr. C. J. G. Palmour, who we have very much pleasure in having with us this morning, has unanimously decided to recommend the payment of a final dividend of 12 per cent. on the Ordinary Shares, making with the 8 per cent. interim dividend already paid, a total dividend for the year of 20 per cent. on the Ordinary Shares, against a total of 24 per cent. last year. It is interesting to note that this rate of 20 per cent. on the nominal Ordinary Share capital represents only some 9·2 per cent. on the actual capital, other than Preference capital, employed in the business.

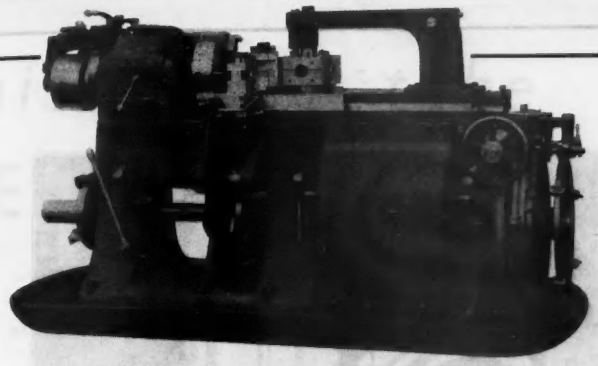
THE FUTURE

That, I think, is about the end of the remarks which can reasonably be made on the Balance Sheet, and it is usual here, I think, to say something about the future. Well, under the existing circumstances, this is a little difficult; we are really more concerned with the immediate present. The ratio of commercial to Government work has, of course, been to a great extent, and is likely to be still further upset. We are taking our instructions from the Authorities who alone are in a position to know in what direction we can be most useful. Every person connected with the firm has been working, and will continue to work, to his or her utmost capacity. This is only to be expected of us in the present state of affairs, which I am sure you will agree we all trust and hope will be of as short a duration as is reasonably and justifiably possible.

The Report and Accounts were unanimously adopted, and the dividend recommendation approved.

The retiring Directors, Mr. J. H. Kemp-Welch, M.B.E., and Engr. Rear-Admiral F. G. Haddy, M.V.O., were re-elected; the Auditors, Messrs. Whinney, Smith and Whinney, were reappointed.

The proceedings terminated with a hearty vote of thanks to the Chairman, Directors, and Staff.



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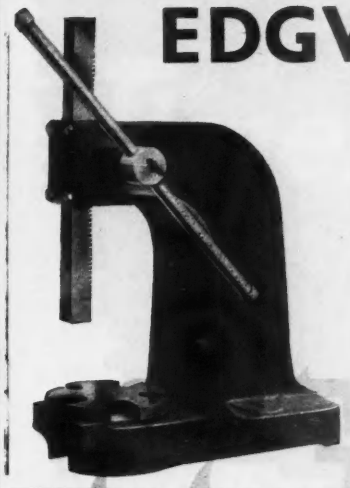

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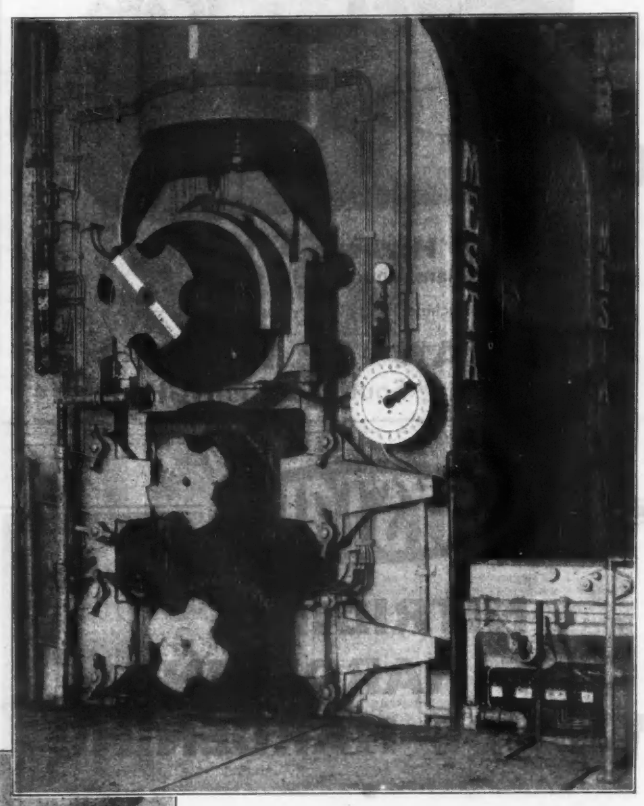

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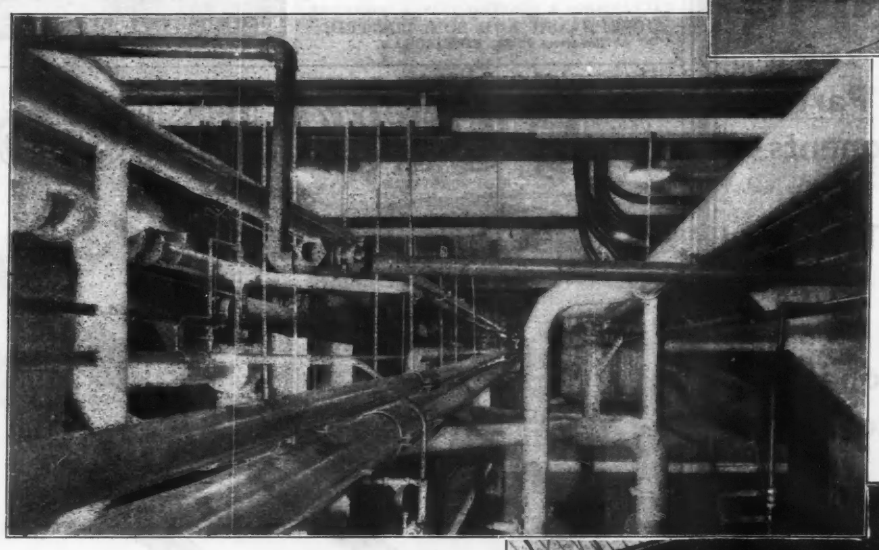

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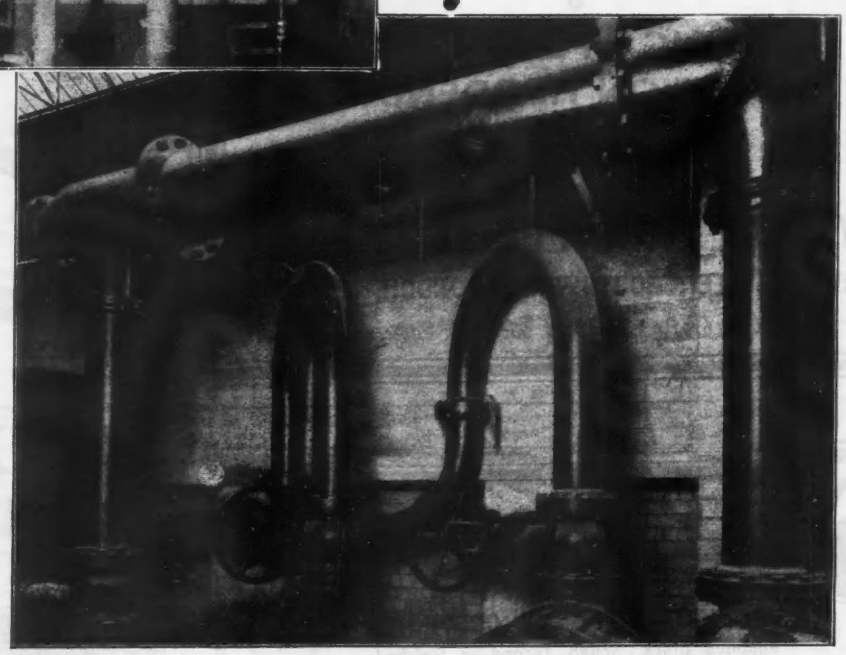

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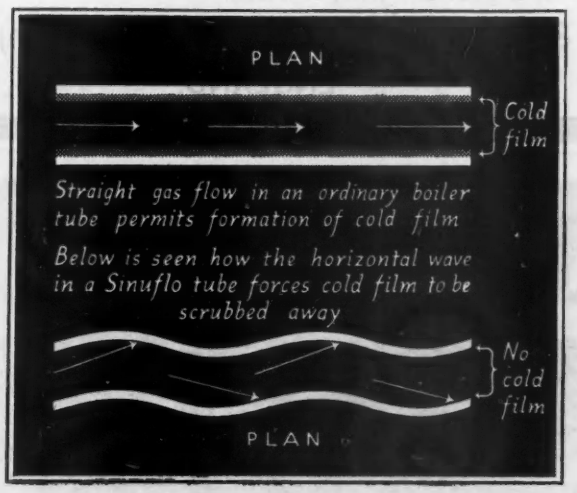
PLAN
Cold film
Straight gas flow in an ordinary boiler tube permits formation of cold film
Below is seen how the horizontal wave in a Sinuflo tube forces cold film to be scrubbed away
No cold film
PLAN

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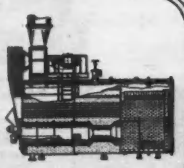

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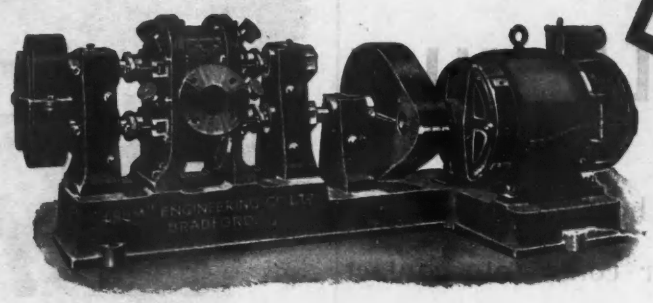

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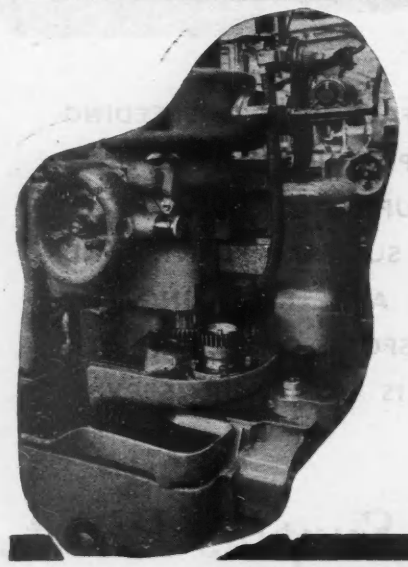

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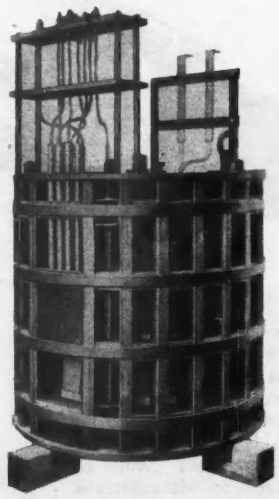

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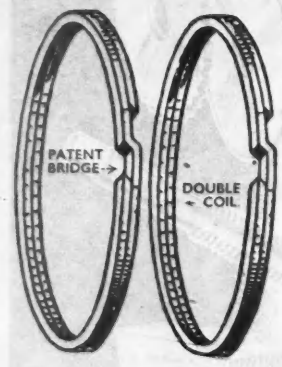

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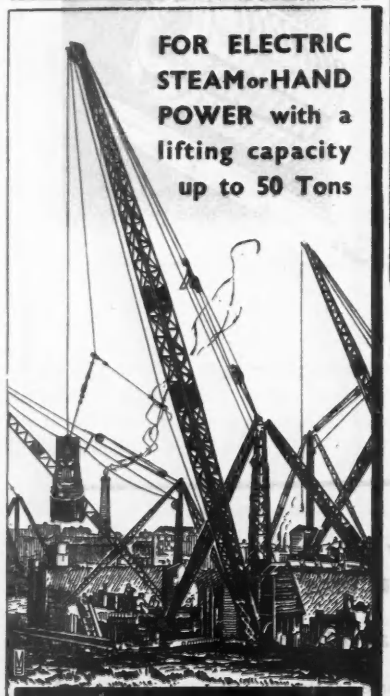

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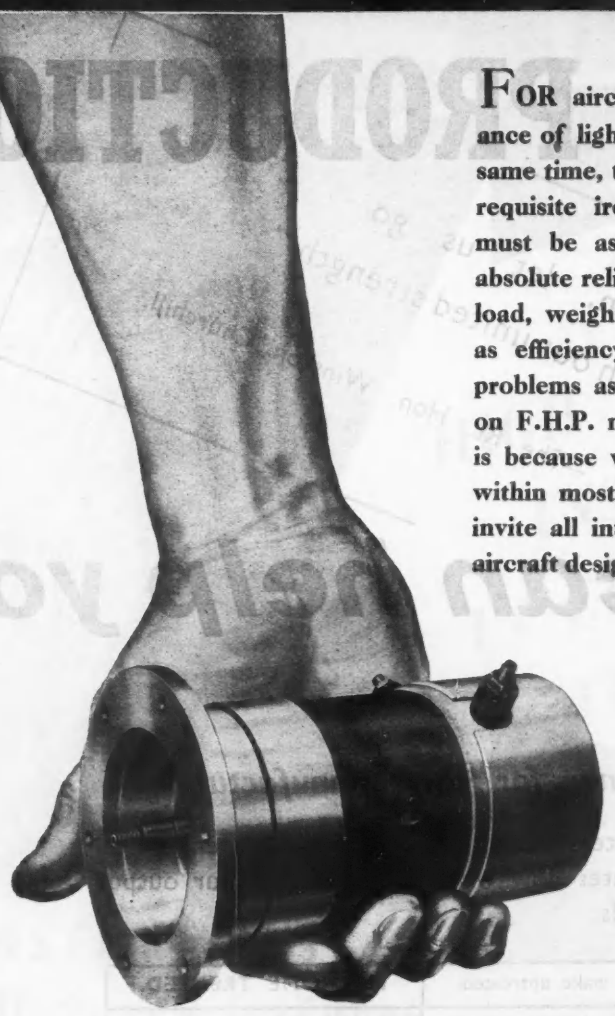

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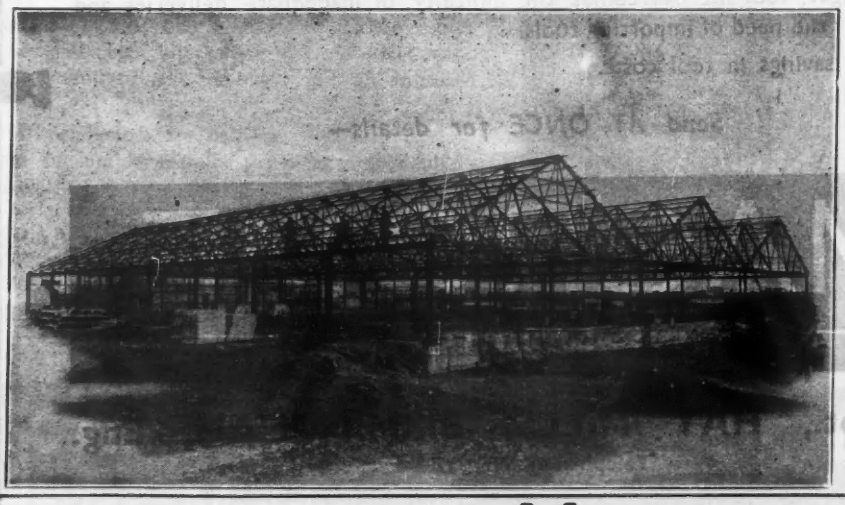

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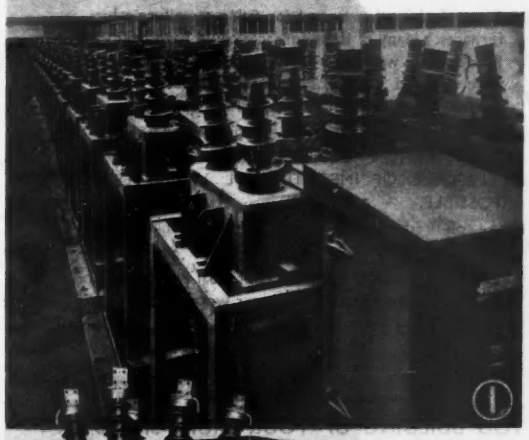
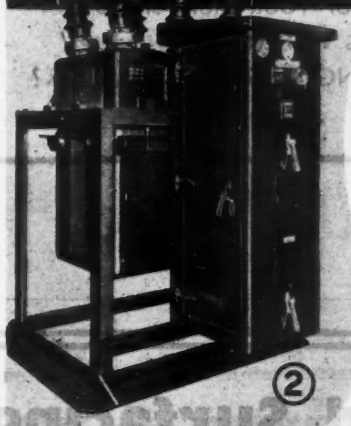


1. *Group of Type OKH3C Oil Circuit Breakers.*
2. *Type OKH3C 11kV. 500MVA. Breaking Capacity Oil Circuit Breaker.*
3. *Type OKH2C 11kV. 250MVA. Breaking Capacity Oil Circuit Breaker showing spring closing mechanism.*



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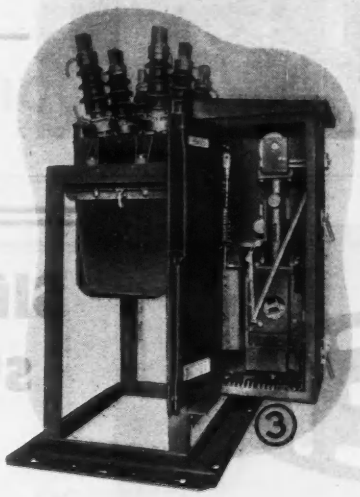

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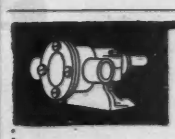

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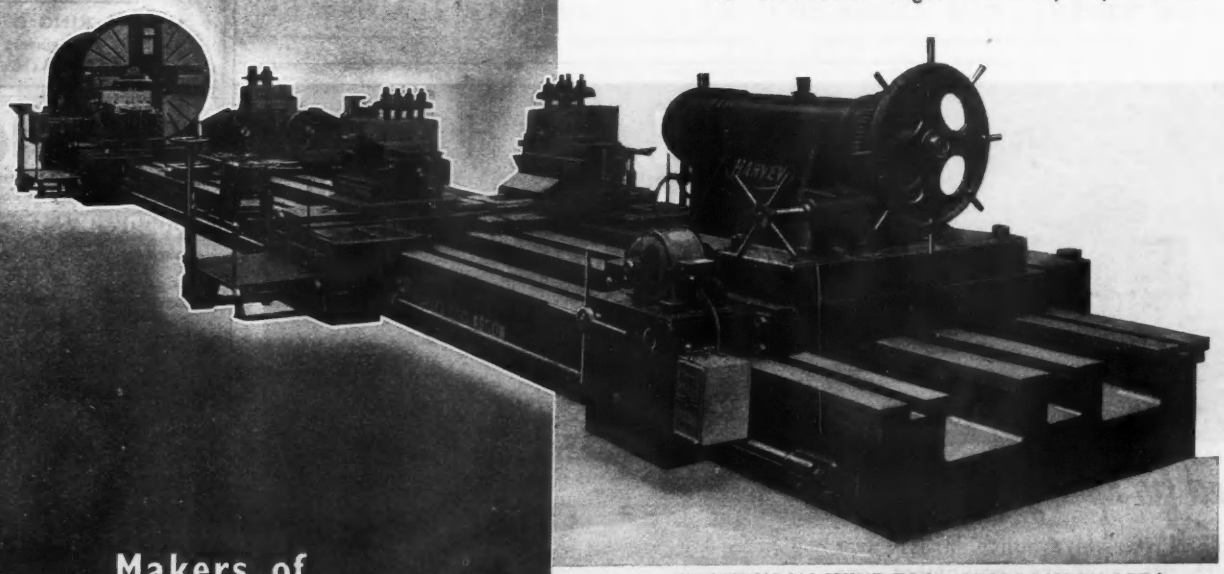

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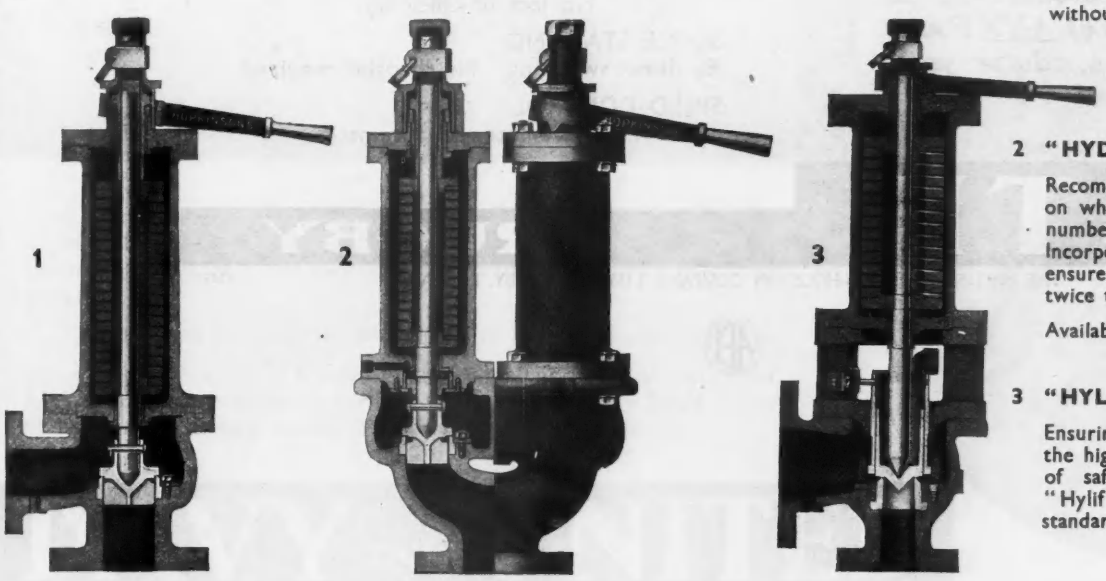

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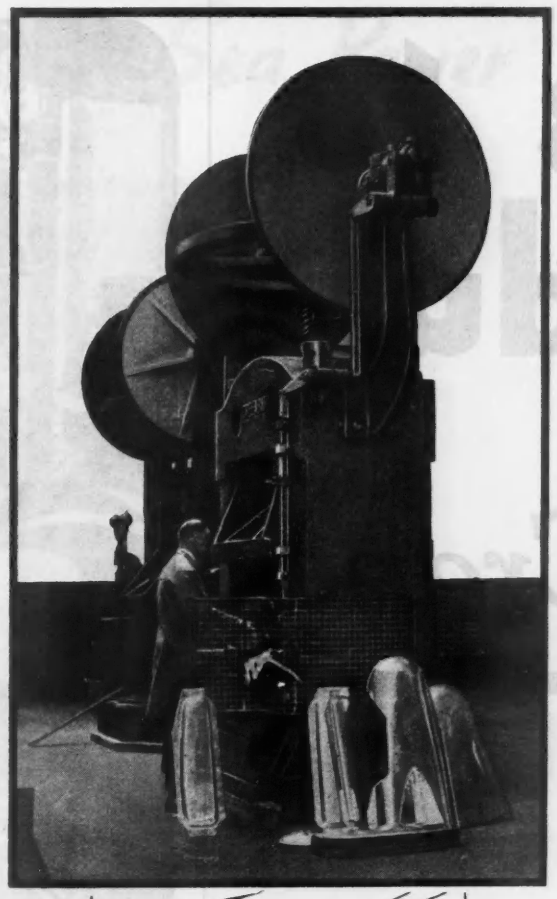
The press illustrated combines many features of the crank press with the friction discs and screw of the screw press.



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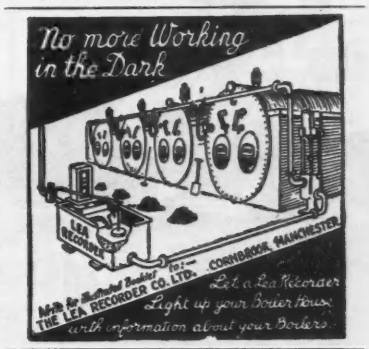
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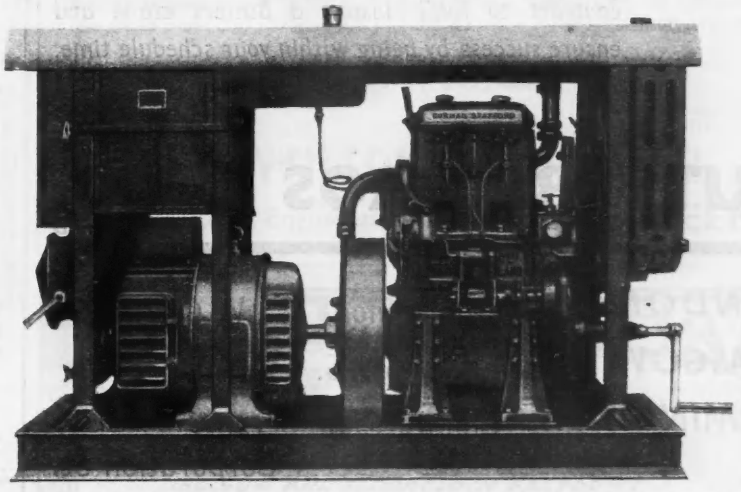

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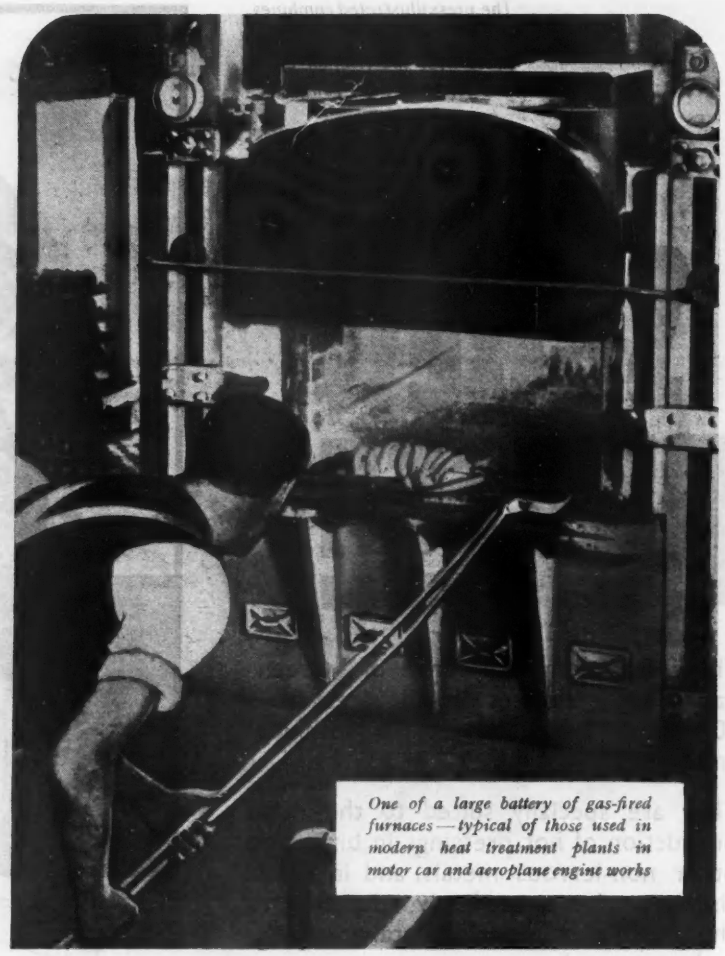

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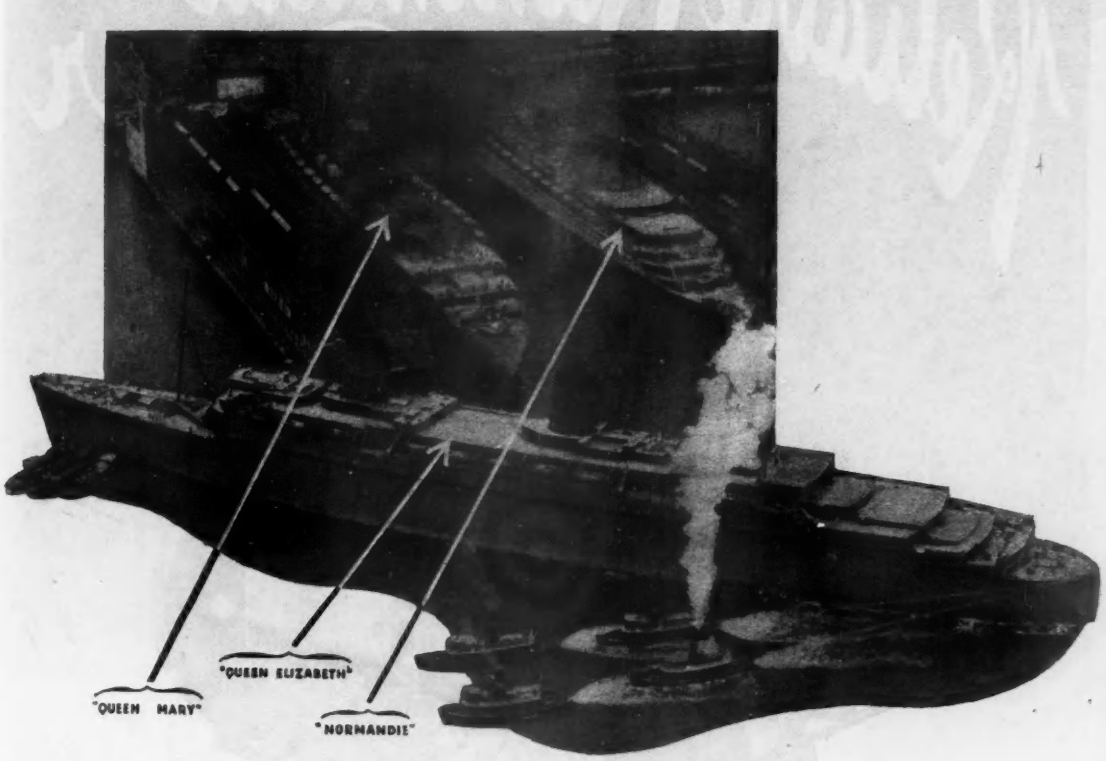

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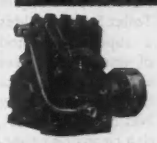

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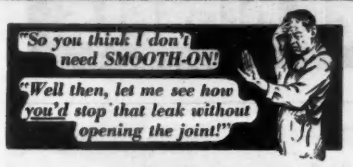

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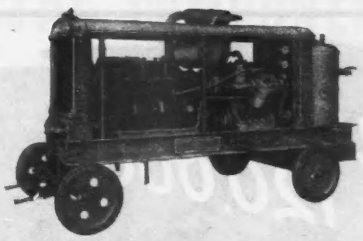

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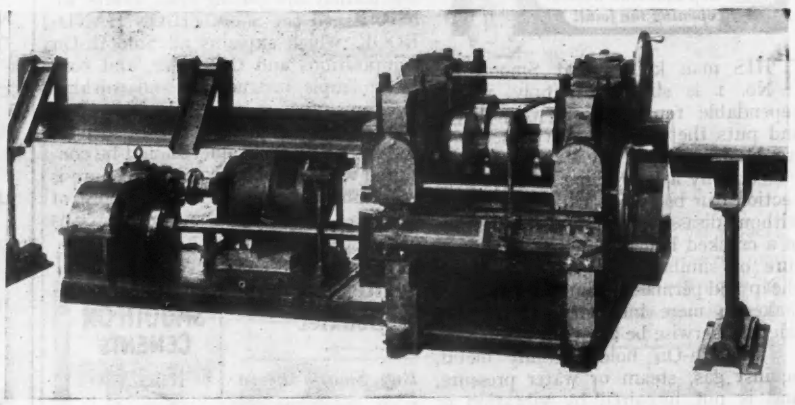

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Single action TOGGLE PRESS

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Weight	130 lb.	Adjustment on ram	$\frac{1}{8}$ in.
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Maximum stroke	$1\frac{1}{8}$ in.	Centre line to back face	3 in.
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May we arrange to show you how it would help on your own jobs?

Single Action Toggle Press

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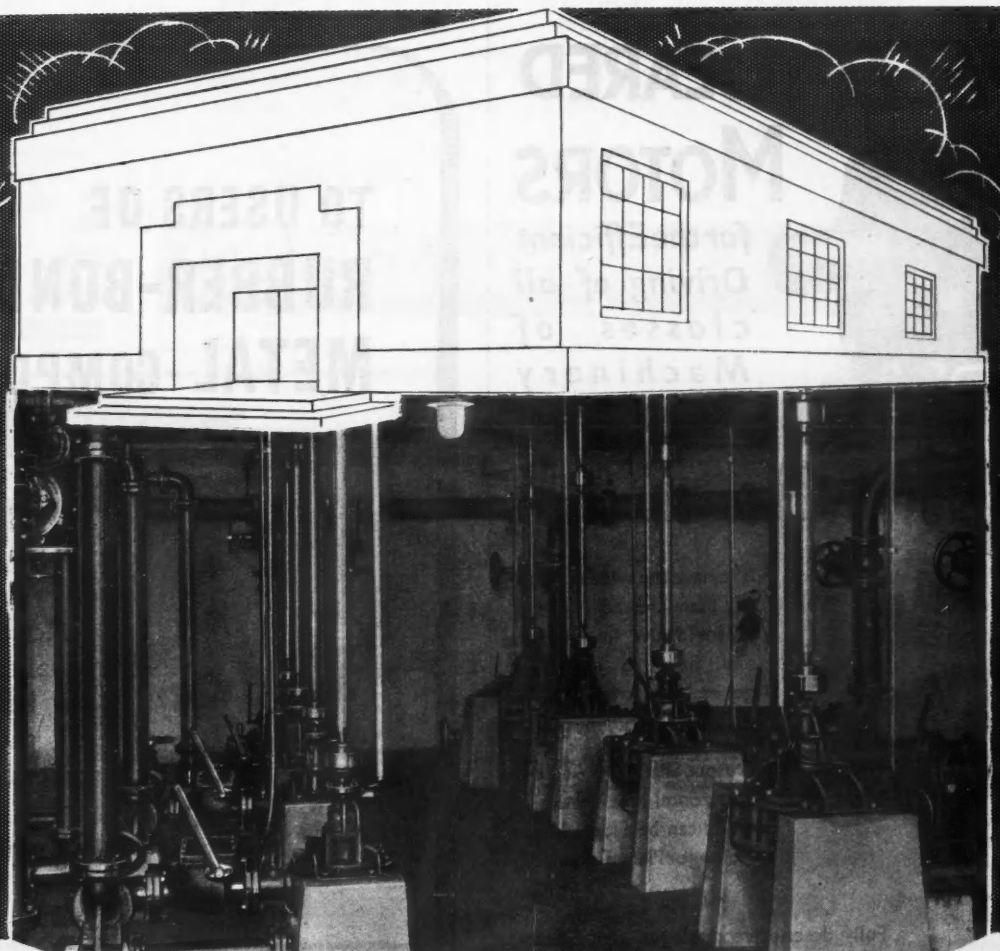

SEWAGE PUMPS

GWYNNES PUMPS LIMITED
HAMMERSMITH W. 6.

BOROUGH of SLOUGH SEWAGE WORKS.,
MESSRS. G.B. KERSHAW & KAUFMAN
Consulting Engineers:

ROBERT HUDSON LTD
LEEDS

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TELEPHONE: 2.0.0.0.4 LEEDS

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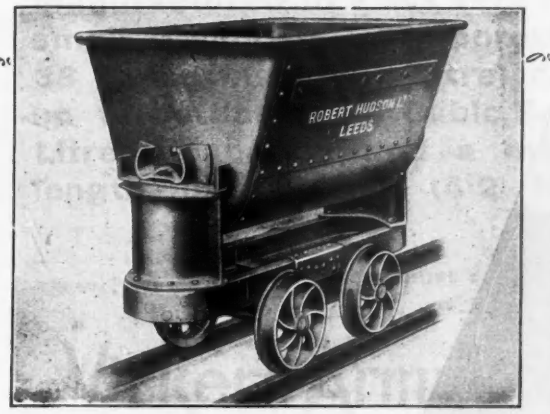
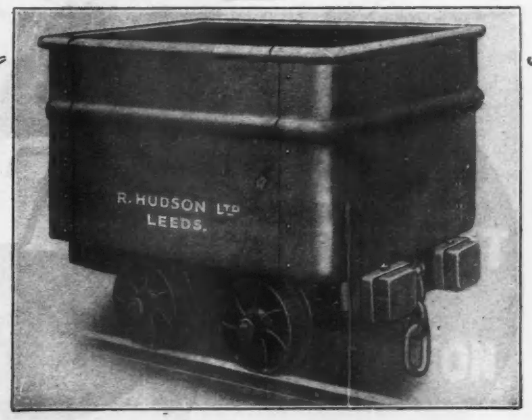
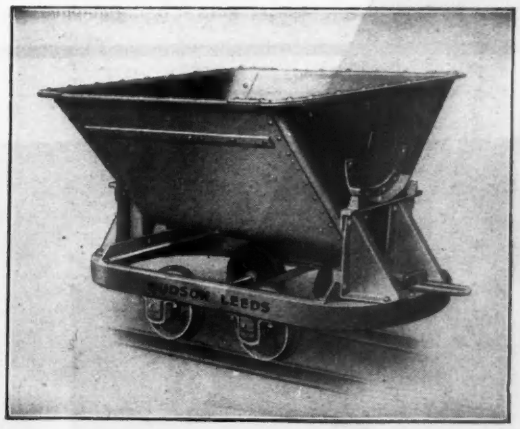
CABLES: "RALETRUX" (ALL OFFICES)



MINING TRUCKS

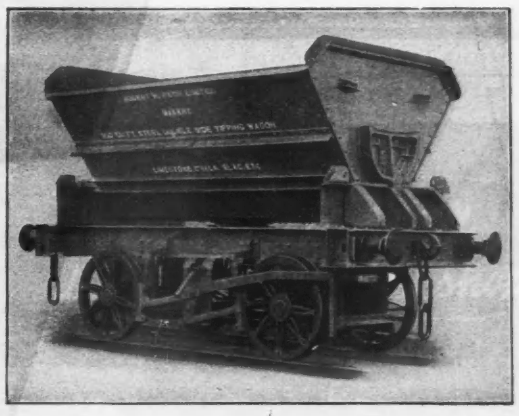
We manufacture countless thousands. Our new patterns (equipped with self-greasing wheels running in ball and roller bearings) are the best money can buy.

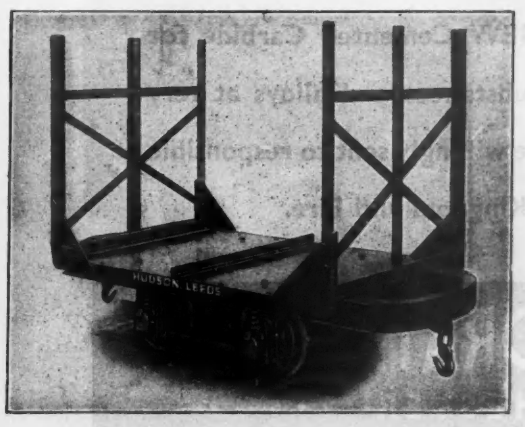




TIPPING WAGONS

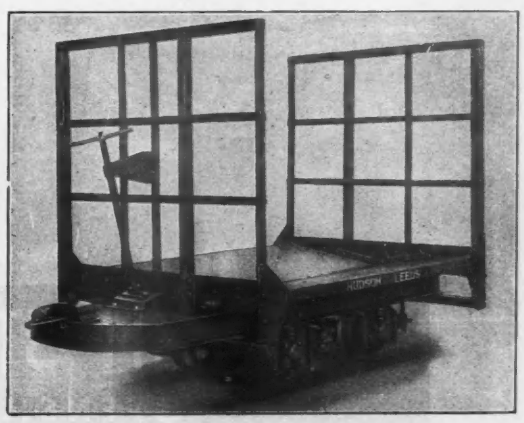
We make all types from the small half-ton size up to the big 15-ton Wagons which automatically empty their load. We keep thousands in stock.





ESTATE CARS

We build large quantities for Sugar and Sisal Estates; they are equipped with our Ball-Bearing Axleboxes and only need lubrication once per season.



MAKERS OF LIGHT RAILWAY EQUIPMENT OF EVERY DESCRIPTION

SOLE SELLING AGENTS FOR — STEAM and DIESEL LOCOMOTIVES — OF ALL SIZES AND TYPES
BUILT BY THE HUNSLET ENGINE CO. LTD.
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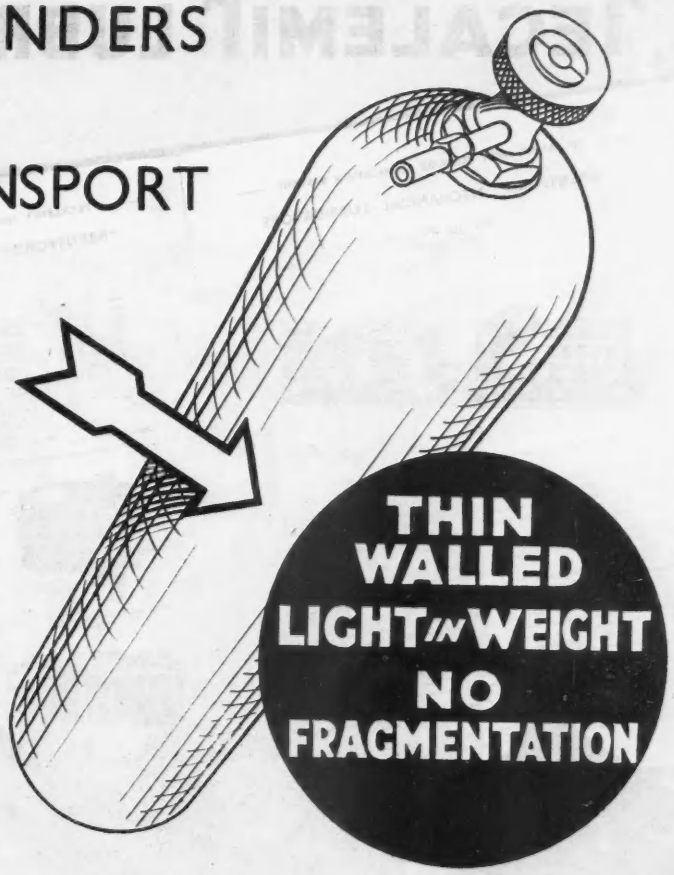
SPECIAL

HIGH PRESSURE CYLINDERS and BOTTLES for STORAGE and TRANSPORT of AIR and GASES.

Manufactured in sizes varying from small Cylinders of approximately 38 Cubic Ins. (0·62 Litre) capacity up to bottles of 28 Cubic Feet (800 Litres) capacity and a maximum length of 14 feet (4·2 Metres).



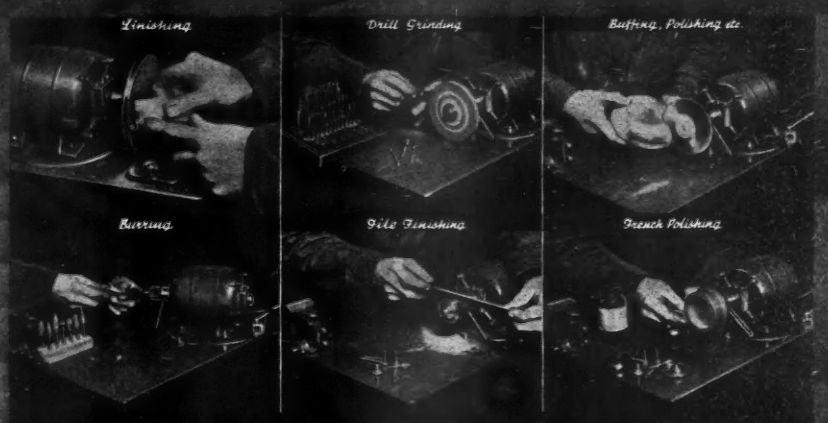
WRITE FOR BROCHURE E8

Vickers-Armstrongs LIMITED

ELSWICK WORKS, NEWCASTLE-ON-TYNE

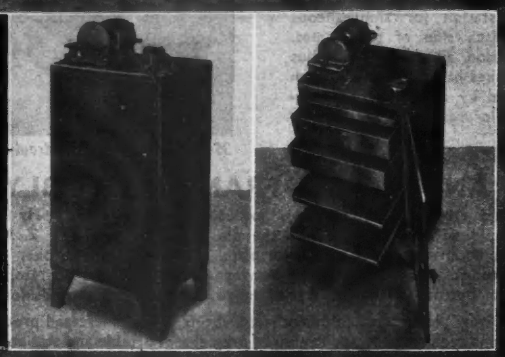
LONDON OFFICE: VICKERS HOUSE, BROADWAY, WESTMINSTER, S.W.1

Phoenix Shopmaster
Has a Thousand Uses in Every Workshop



Overall Dimensions:- Height 36 in. Width 16 in. Depth 15 in.

These illustrations show the neat appearance of the Phoenix Shopmaster and also show the ample storage room provided



The illustrations in this advertisement speak for themselves. The Phoenix Shopmaster is an ideal appliance for a thousand different jobs in every workshop. It will be seen that the arrangement of the swivelling motor enables many types of operations to be performed efficiently. The standard equipment includes a linishing wheel which is easily removed from the taper spindle by a quick release device, chuck and key, tool rest, vice and complete electric wiring with switch mounted behind the cabinet. The cabinet itself is provided with ample storage accommodation in the form of removable drawers and trays.

E. H. Jones (MACHINE TOOLS) LTD

Phone Colindale 7272-5 · EDGWARE RD, THE HYDE, LONDON, N.W.9 · Telegrams Garantools Hyde London

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TECALEMIT HIGH PRESSURE LUBRICATION SYSTEMS
"BRENTFORD" MECHANICAL LUBRICATORS
FOR USE WITH OIL
(PATENT NO. 510,717)
TECALEMIT HIGH PRESSURE LUBRICATION SYSTEMS
"BRENTFORD" MECHANICAL LUBRICATORS
FOR USE WITH OIL
"B" SERIES FOR DIRECT ROTARY DRIVE
"B" SERIES MODELS FOR ROTARY DRIVE
THREE PINT MODELS
SIX PINT MODELS
TECALEMIT LTD., GREAT WEST ROAD, BRENTFORD, MIDDLESEX
OK for Production but specify Tecalemit Lubrication
TECALEMIT

TECALEMIT LTD. GREAT WEST RD., BRENTFORD, MIDDX. 'Grams: "Tecalemit, 'Phone, London" Phone: EALing 6661 (12 lines)

THE INDUSTRIAL SPEED UP—

EFFICIENT LUBRICATION IS

VITAL

Every experienced engineer understands the value of efficient lubrication. Lubricant is the "life blood" of the machine, and in these days of intensive production with machines working night and day, week in, week out, it is of vital importance to guard against breakdown. Tecalemit high pressure lubrication has been brought to a fine art through years of practical experience in its application to every class of machinery, and is now universally recognised by designers of plant as the most effective means of ensuring trouble-free working and long life for all moving parts.

Submit all your lubrication problems to:

INDUSTRIAL DEPARTMENT,
TECALEMIT LTD.
GREAT WEST ROAD, BRENTFORD, Mddx.
Telephone: EALing 6661 (12 lines)

"Radial" Lubricating Grease Pump. Model 17850

HANNIFIN "Hy-Power" HYDRAULIC RIVETERS

17½-ton "Hy-Power" Hydraulic Riveter.

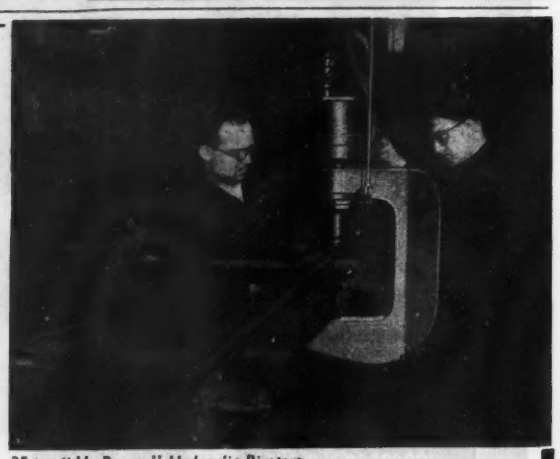
SOLE AGENTS:—

BROADWAY *Engineering Company Ltd*

CARLISLE ROAD, HENDON, LONDON, N.W.9

PHONE: COLINDALE 8681 (5 LINES) GRAMS: RETOOL, HYDE, LONDON
BIRMINGHAM: Somerset House, 37, Temple St., Birmingham 2.—Midland 6702

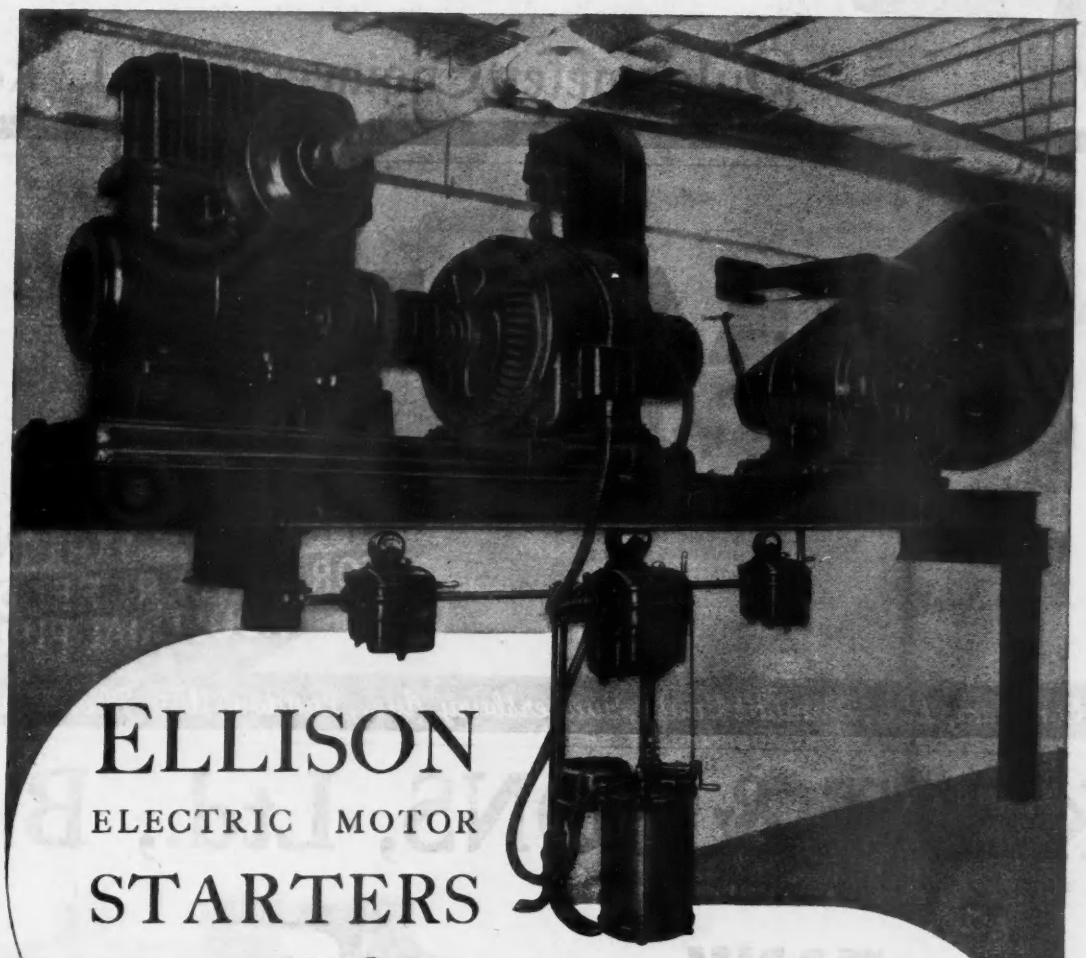
The truck frame assembly line illustrates the convenient handling and high speed operation of Hannifin "Hy-Power" hydraulic riveting equipment. The use of "Hy-Power" portable units allows bringing the riveter to the work, with most convenient assembly of the various frame parts, and fast, steady production. Duplicate riveters are provided at each station for simultaneous operations on each side of the frames. Balanced suspension allows ample radius of action and makes handling easier. Each riveter is served by an individual "Hy-Power" hydraulic pressure generator.



35-ton "Hy-Power" Hydraulic Riveters.

FASTER AND EASIER FRAME ASSEMBLY. High speed operation results from the automatic, push button controlled riveter cycle which is exclusive with Hannifin "Hy-Power" equipment. This cycle includes: 1. Rapid advance stroke until the die touches the rivet; 2. Automatic high pressure working stroke; 3. Automatic reversal at peak pressure; 4. Rapid return stroke. The motor driven "Hy-Power" pressure generator idles at zero pressure between cycles. All the operator does is position the riveter and press the control button. Operating cycles range from 1½ to 3 seconds for 3 to 4 inch stroke units.

Hannifin "Hy-Power" hydraulic equipment is delivering greatly increased production and convenience to a wide range of operations requiring the application of pressure. Portable and stationary units are available in capacities from 7½ to 50 tons capacity for riveting, punching, pressing, press-assembly, stamping, forming, and similar work. Bulletin 42 illustrates many standard types, and may point the way to important economies for you. Write for your copy.



ELLISON
ELECTRIC MOTOR
STARTERS
are reliable...

The illustration shows Ellison Starters controlling a 65 h.p. electric motor driving twelve milling machines, and a 25 h.p. motor driving five scourers in a Yorkshire Cloth Mill.

In addition, Ellison starters are used to control motors driving looms, rag pulling machines and carding and condensing sets, and an Ellison circuit breaker controls the whole of the supply to the Mill.

GEORGE ELLISON
LIMITED
BIRMINGHAM 22 ENGLAND

Photograph by courtesy of the "Electrical Review"

The electric motors were manufactured and installed by Messrs. Brook Motors Ltd.

407

CENTRIFUGAL PUMPS

Bex Type Pump.

PULSOMETER ENGINEERING CO. LTD. LONDON & READING

HEADS UP TO 180 FEET.
OUTPUTS UP TO 100,000 GALLONS PER HOUR.

"Pulsometer" BEX and LEX pumps have specially large diameter shafts and two external bearings which support the shaft without help from the stuffing box bush.

These robust pumps are strongly recommended for arduous duties. May be direct coupled or belt driven.

Write for List No. 2508.

Pulsometer Engineering Co. Ltd. Reading

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WATER TREATMENT
FOR BOILER FEED & ALL INDUSTRIAL PURPOSES

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PECKETT & SONS, Ltd., Bristol

Telegrams PECKETT, BRISTOL

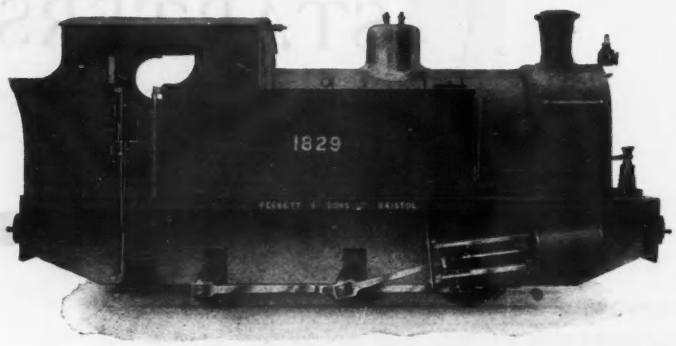
London Representatives : FERGUSON & PALMER
9, Victoria Street, Westminster, S.W.1

Speciality :

TANK LOCOMOTIVES

of all Descriptions, and any Size or Gauge

FULL PARTICULARS ON APPLICATION



FIRTH-BROWN ENGINEERS' TOOLS

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BUILDERS OF RAILWAY CARRIAGES, WAGONS, ELECTRIC CARS, and every other description of RAILWAY and TRAMWAY ROLLING STOCK. Makers of WHEELS, AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, AND IRON AND BRASS CASTINGS. Registered Office and Chief Works: MOTHERWELL. Sheffield Office: Town Hall Chambers, 87, Fargate, 1. London Offices: 29, Great St. Helen's, Bishopsgate, E.C.
See illustrated Advertisement page 32 last week.

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(ESTB. 1864.)
MANUFACTURERS OF
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G. R. TURNER, LTD.
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RAILWAY ROLLING STOCK & MINING MACHINERY
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London Office . 32, Victoria Street, S.W.1
Illustrated Advert. in Issue of May 24th, page 5.

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MALLEABLE IRON CASTINGS in Black-heart & White-heart, HIGH DUTY GREY IRON CASTINGS, WROUGHT IRON PULLEYS
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BOILER MAKERS & CONSTRUCTIONAL ENGINEERS. STEEL STOCKHOLDERS.
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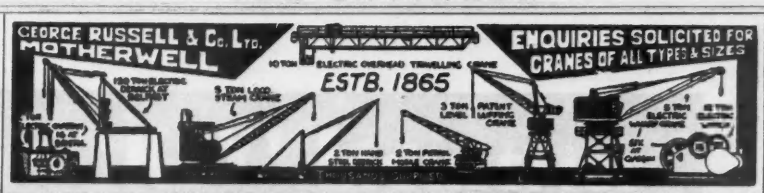

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Makers of EJECTOR
CONDENSERS
for TURBINES or RECIPROCATING ENGINES
AUTO. VALVES, VACUUM BREAKERS, ETC.
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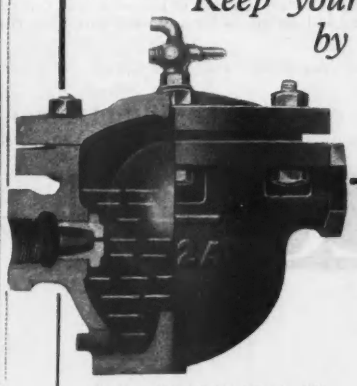
Keep your steam hot and dry by installing . . .

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The Material of Unlimited Uses
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friction clutches
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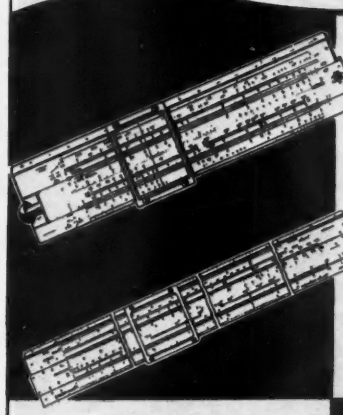
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Introduces a new system of Trigonometrical and other Scales specially designed for electrical calculations. The Rule demonstrates a striking advance in Slide Rule technique for the Electrical Engineer.
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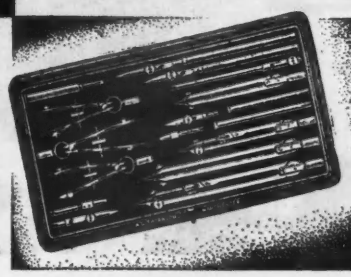
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Paragon Works, King St. West, Manchester 3

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Makers R. BROADBENT & SON, Ltd., Stalybridge
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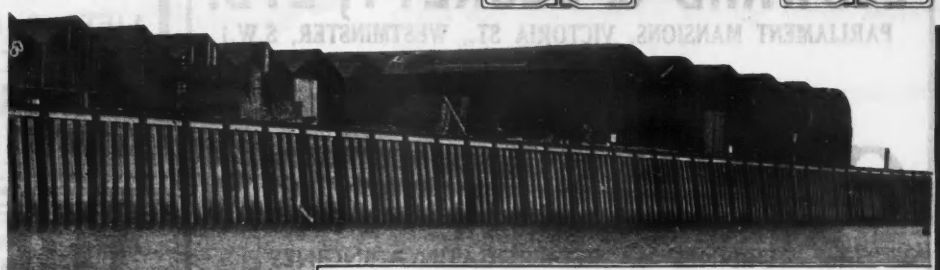

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STRENGTH
SECURITY

A 450 FT. WHARF WALL

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Another great power station

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KEARSLEY POWER STATION

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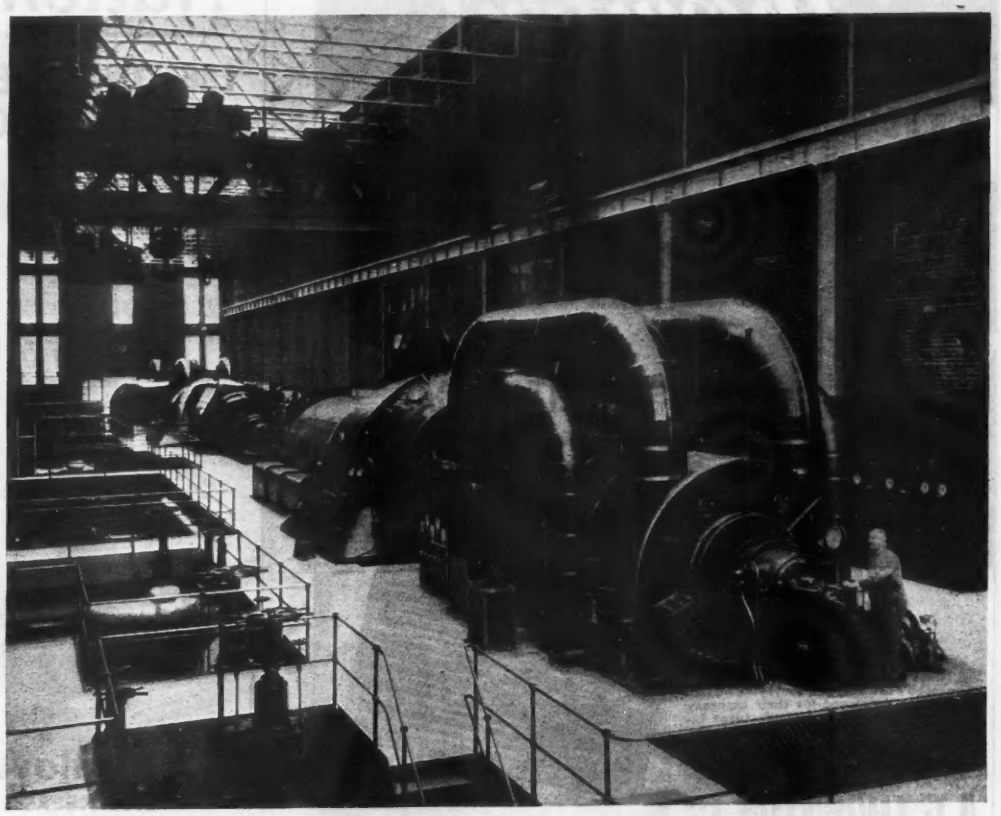
ALL HIGH PRESSURE STEAM PIPES SUPPLIED AND ERECTED BY AITON & CO.

OPERATING STEAM CONDITIONS
625 lbs. per sq. inch, 850° Fahrenheit.



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The 'Heenan' Electric Dynamometer enables the engine to be motored over a wide speed range for running-in or research work, and tests the engine power output on the same test bench. It permits the power absorbed by individual parts of the engine to be accurately measured. The engine power can be recovered in the form of useful electric current.

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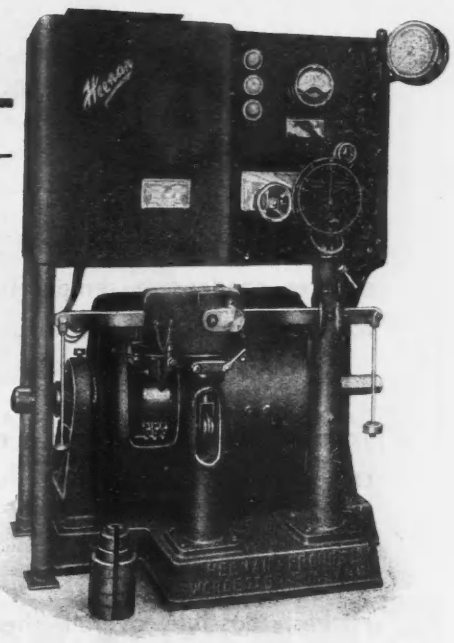
'Heenan' Electric Dynamometers are fully described in Leaflet 92/2 E.G. which we shall be pleased to send you.

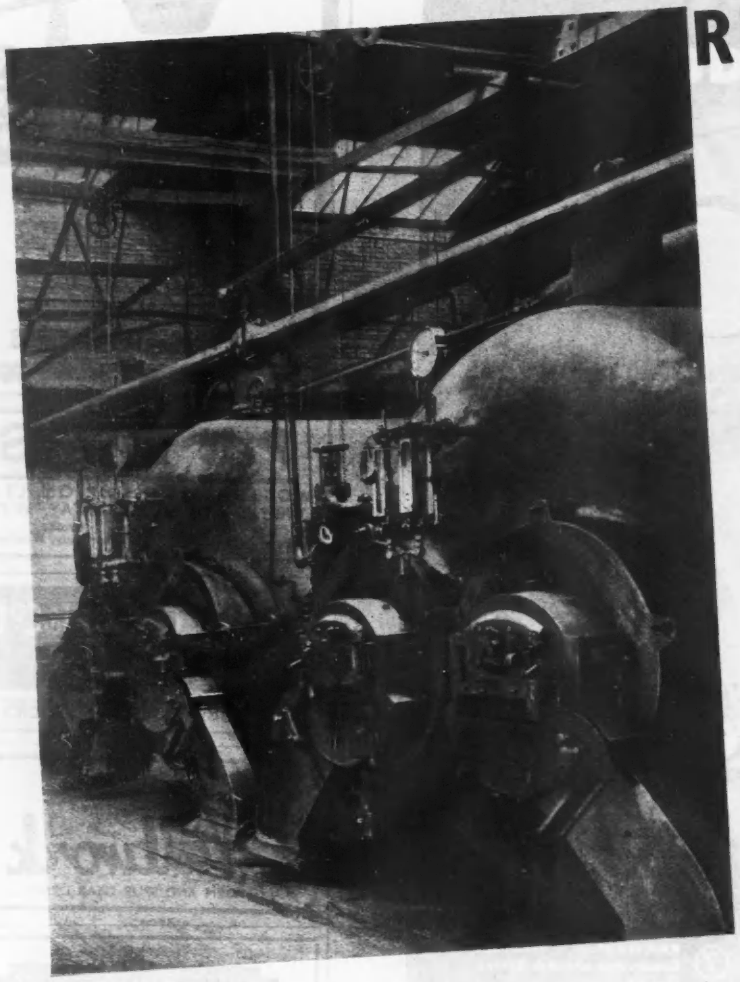
Heenan ELECTRIC DYNAMOMETER

HEENAN & FROUDE LTD.
ENGINEERS WORCESTER



'Heenan' Electric Dynamometer recently supplied for testing medium-speed Diesel engines for road vehicles, etc.

The Measuring Gear is extremely sensitive; the controls and dials are conveniently grouped, and readings are strictly accurate.



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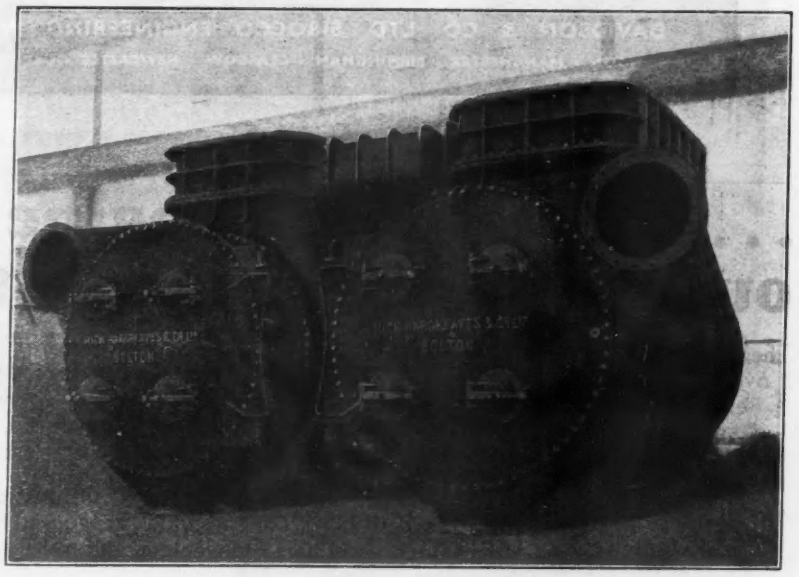

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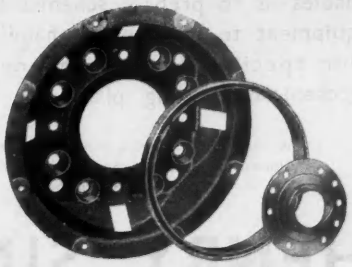

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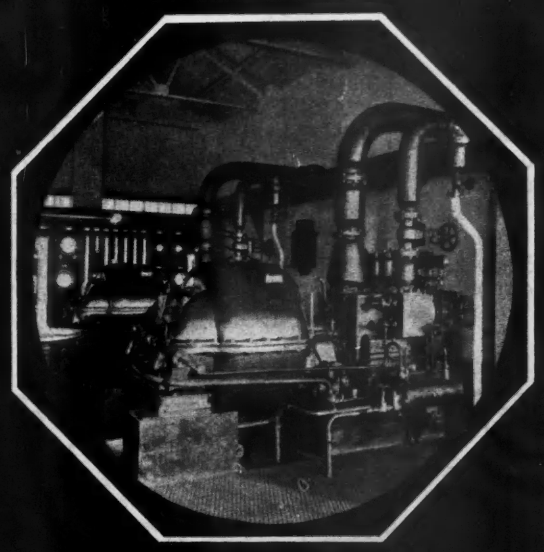

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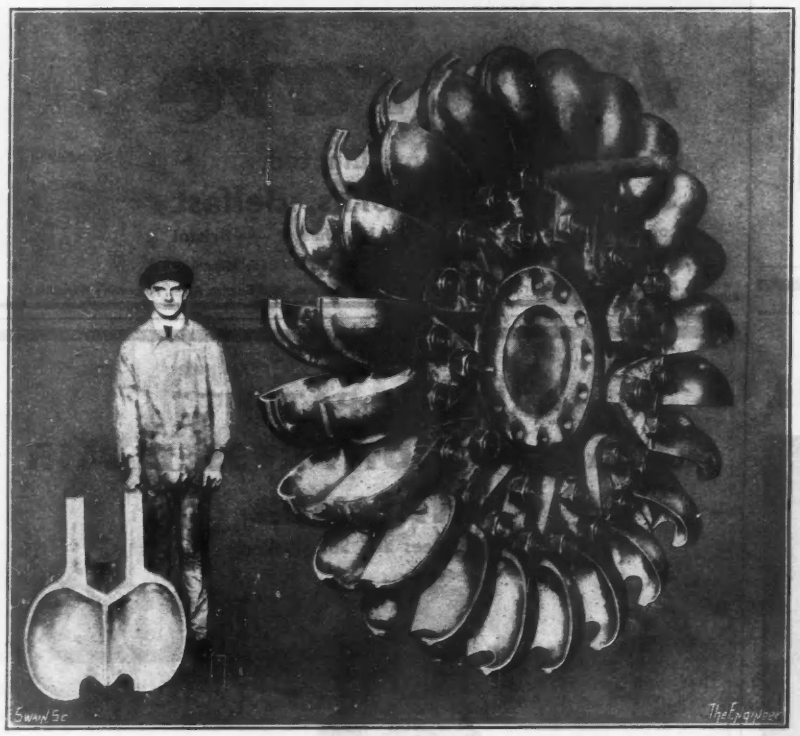

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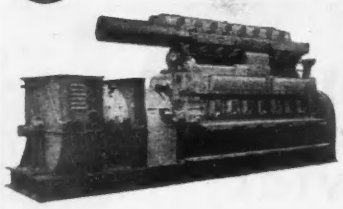

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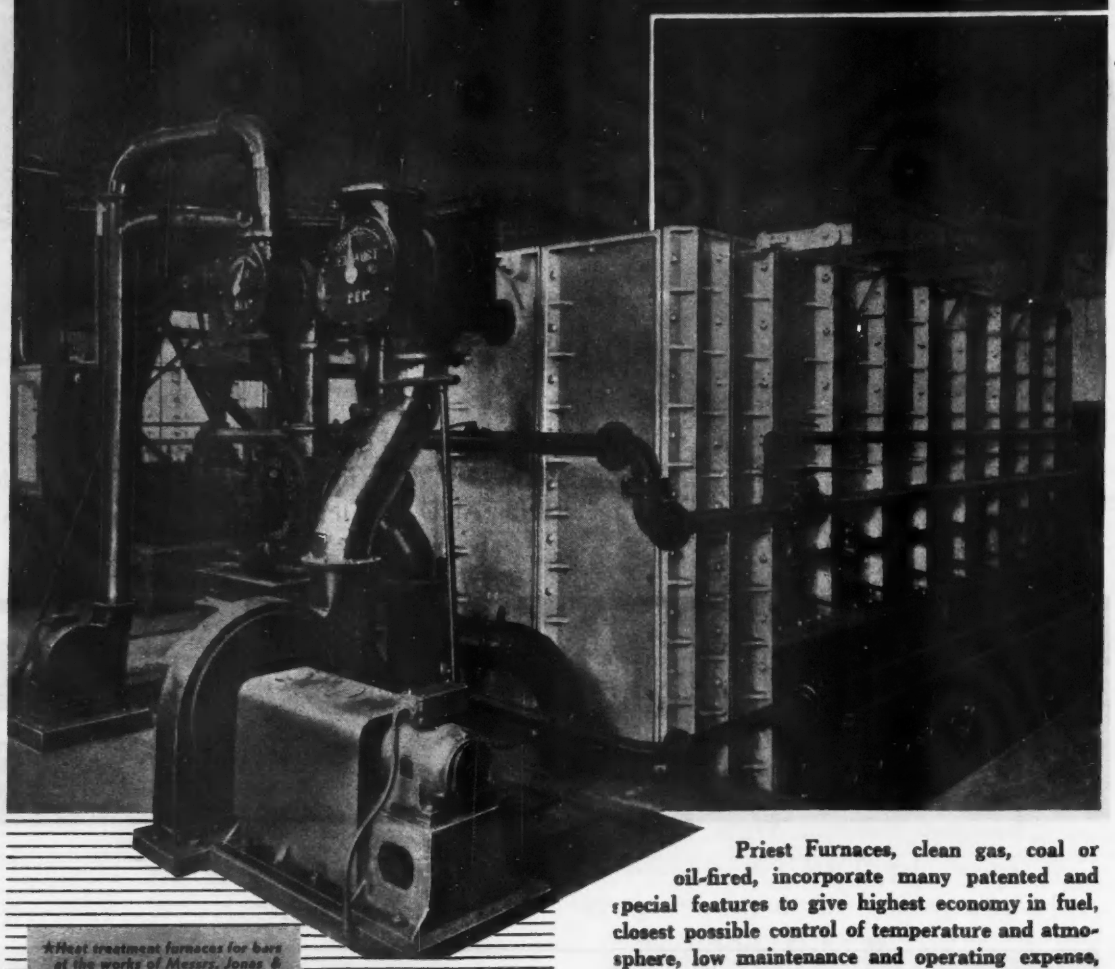

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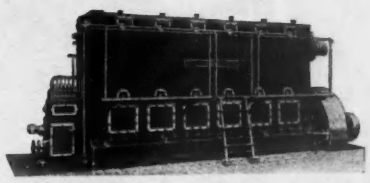

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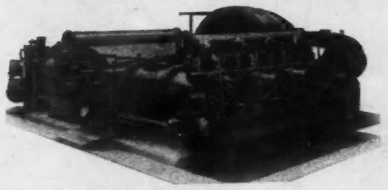

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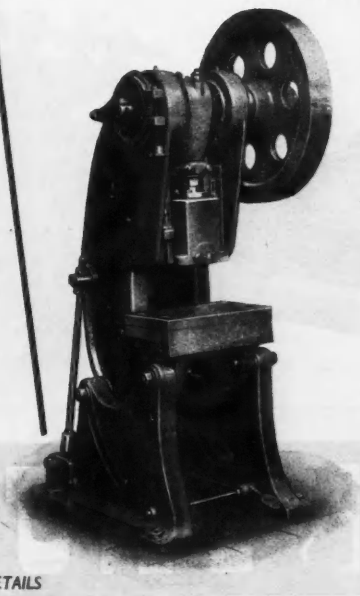

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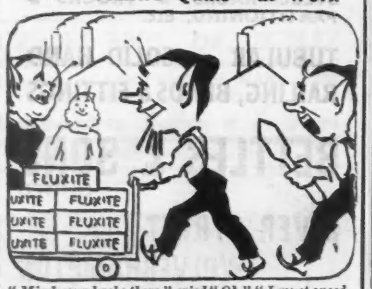

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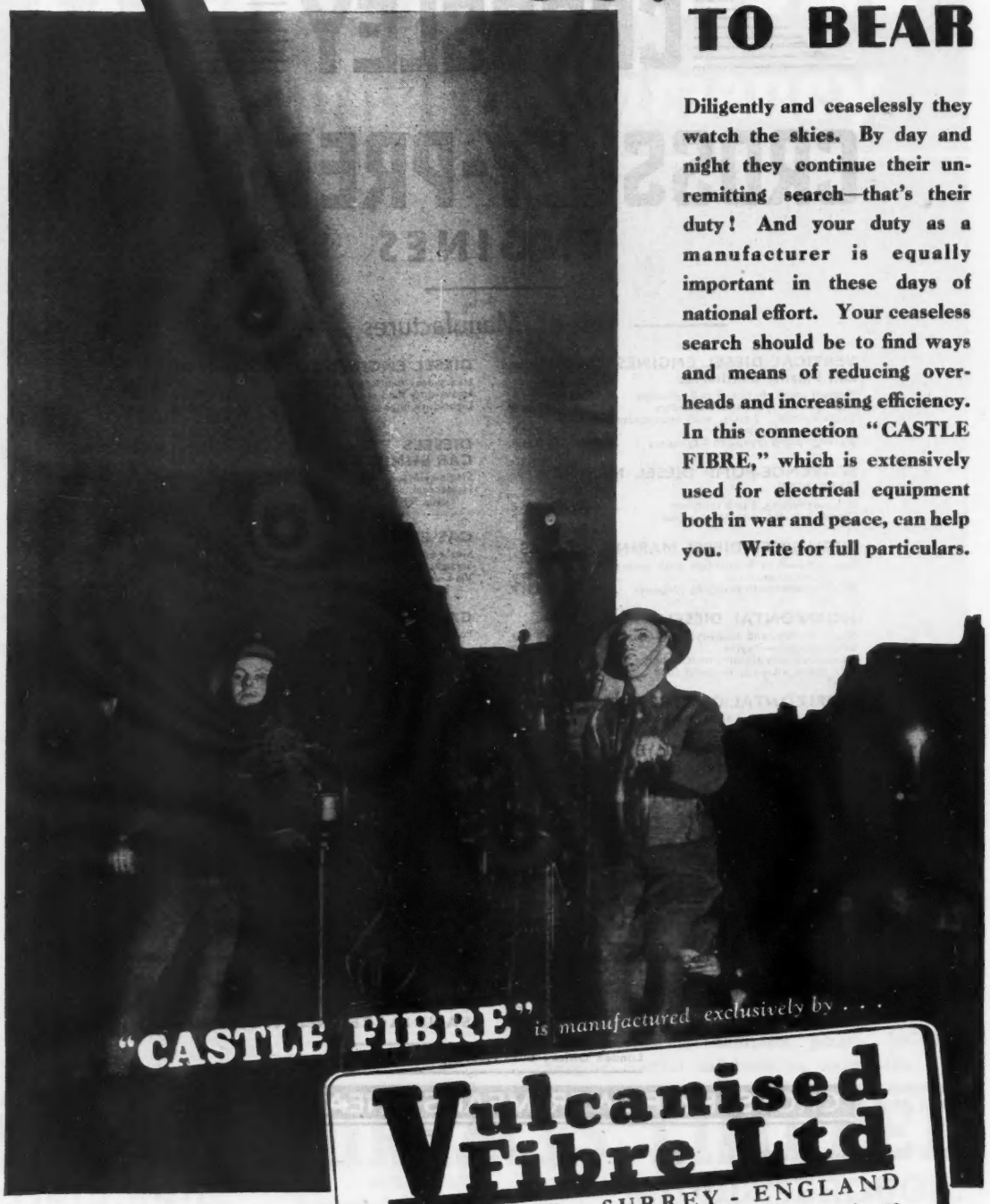

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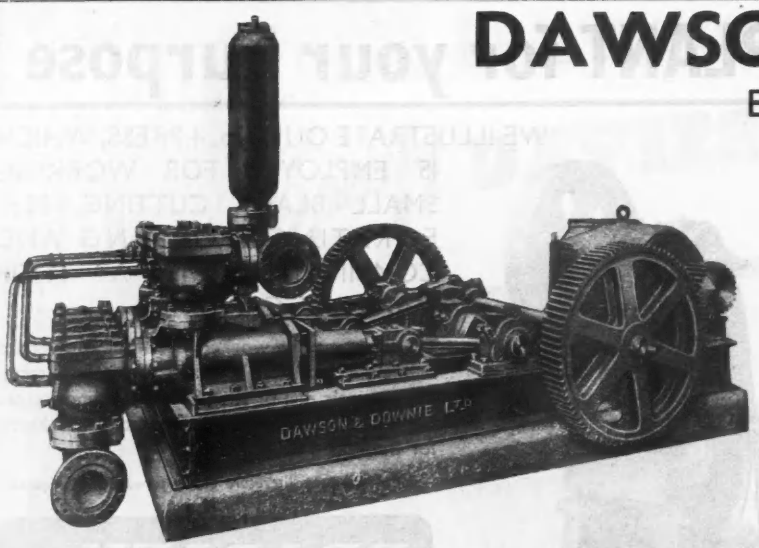

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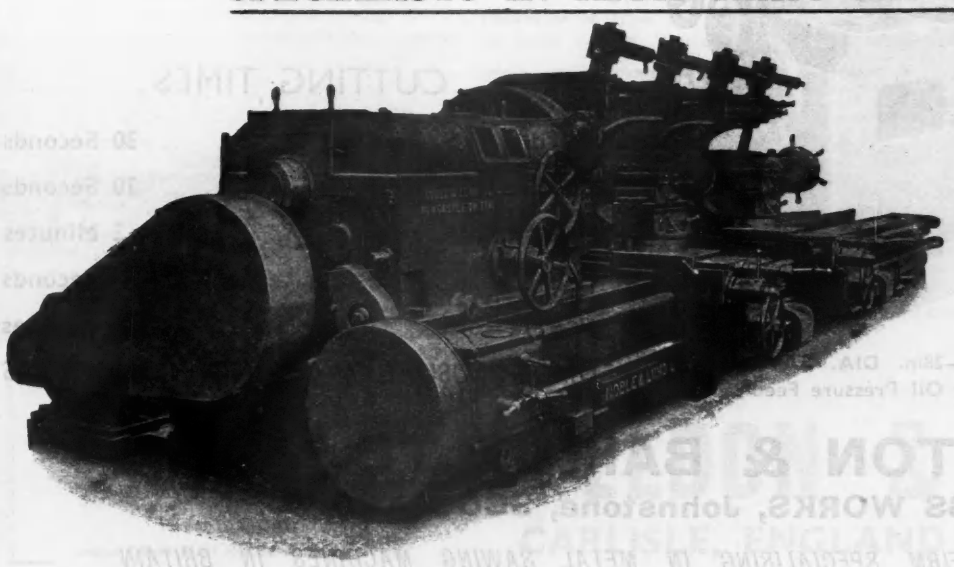

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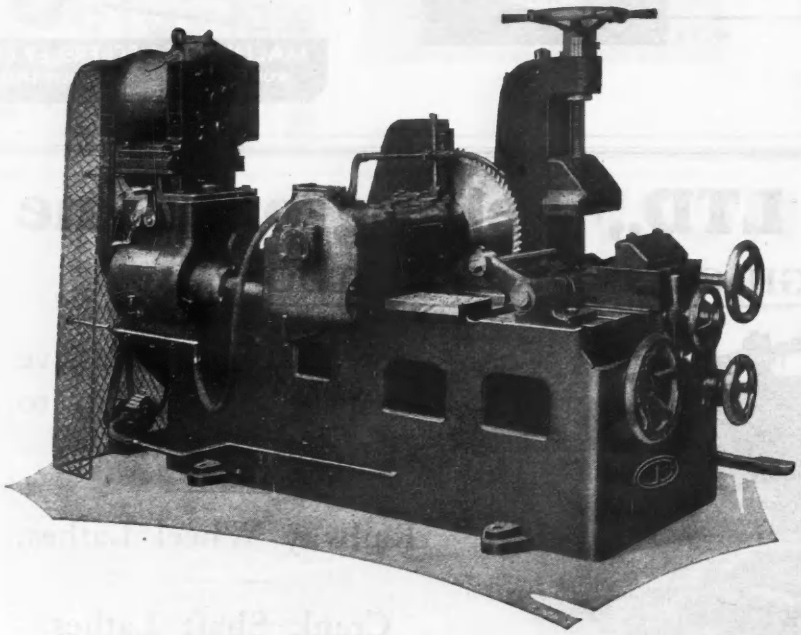

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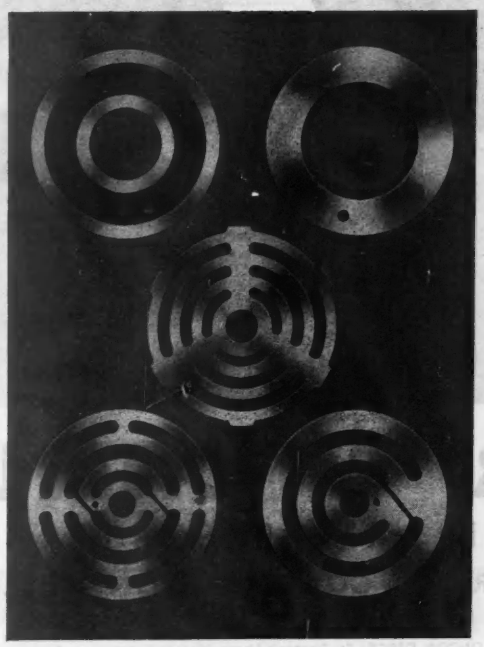

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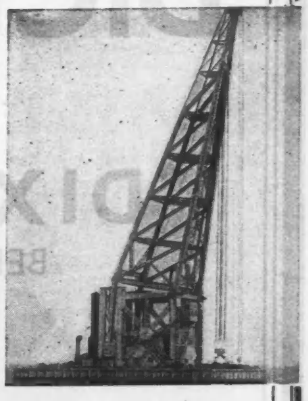

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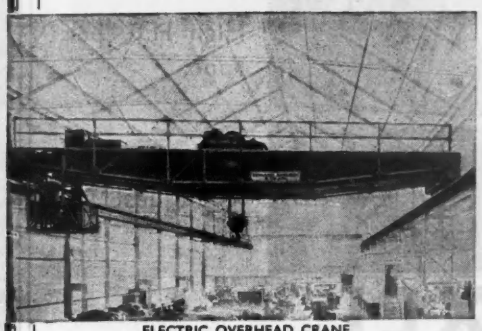

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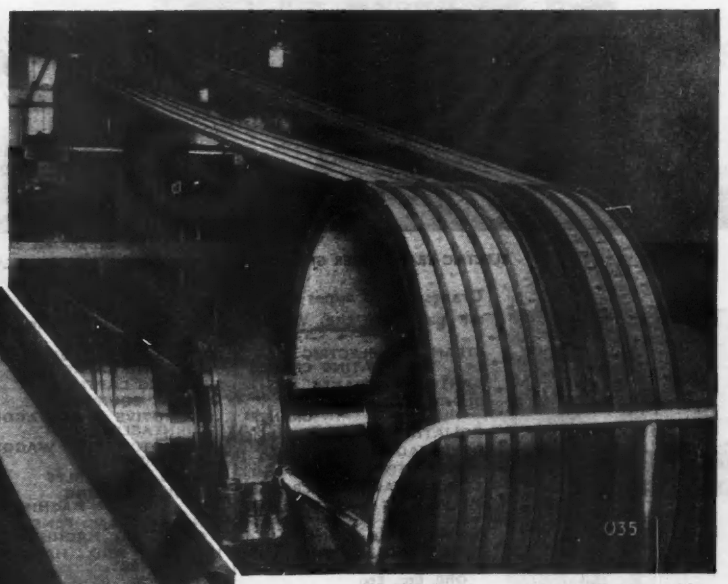

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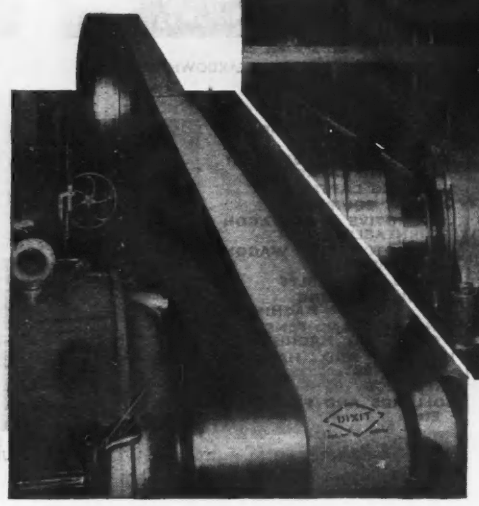

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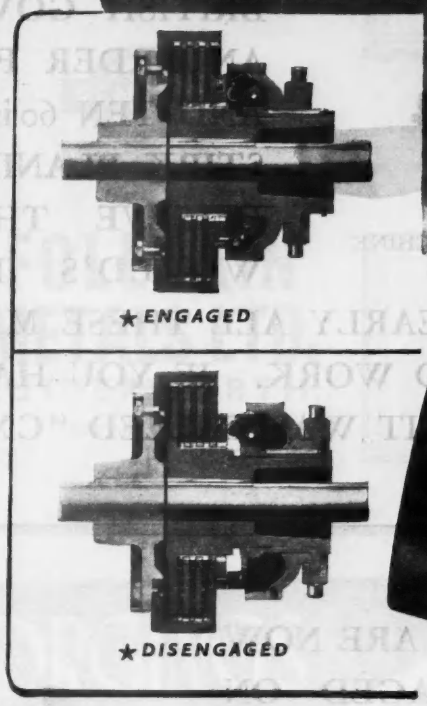

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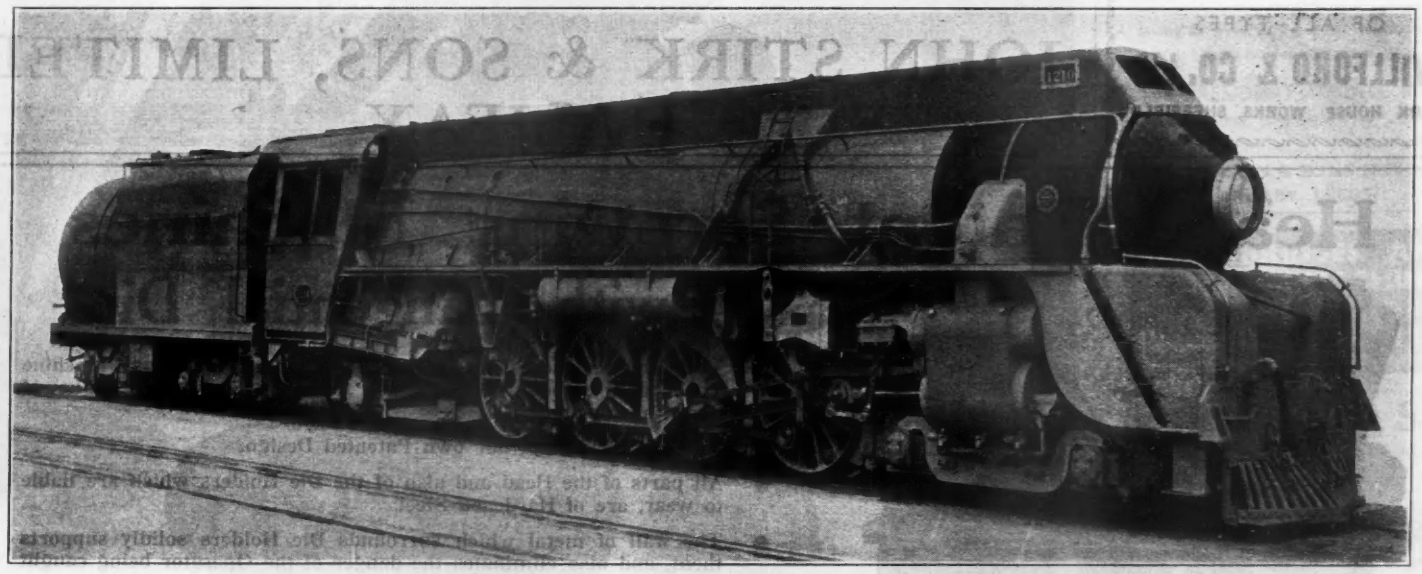

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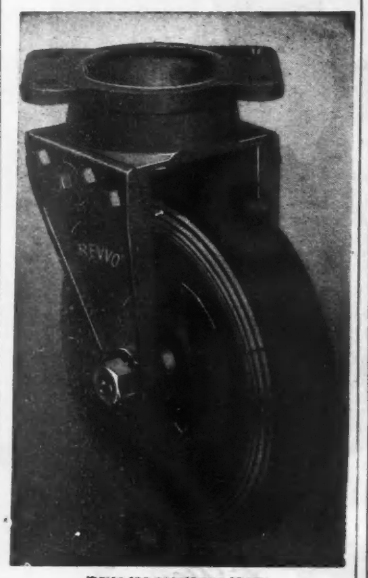

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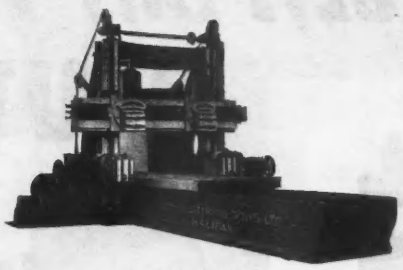

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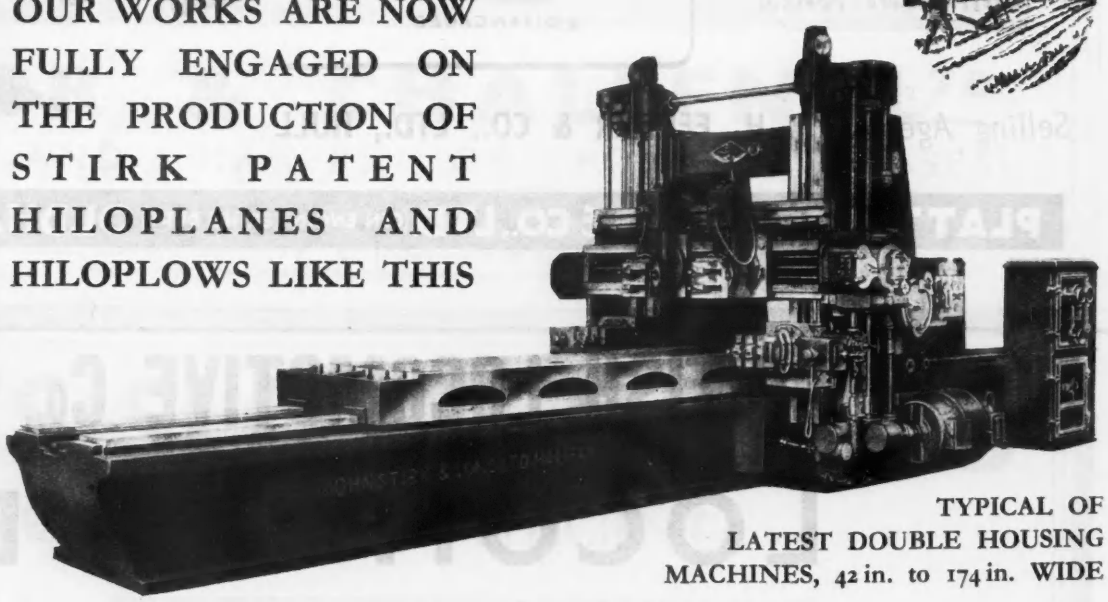

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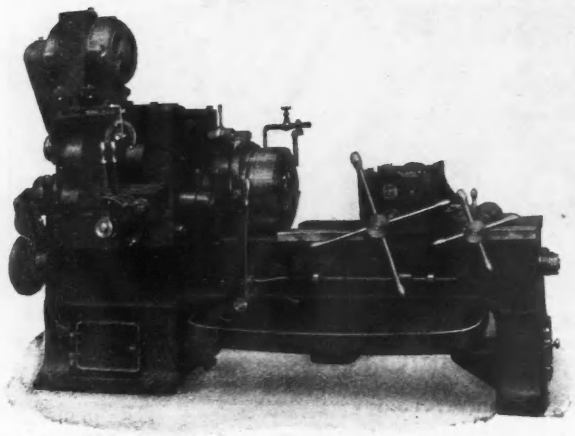

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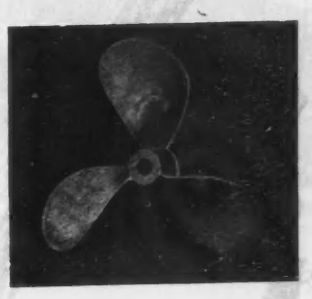

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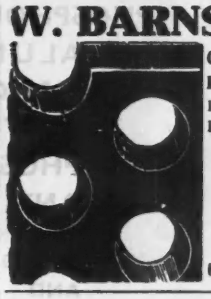

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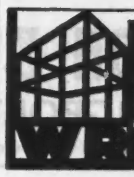

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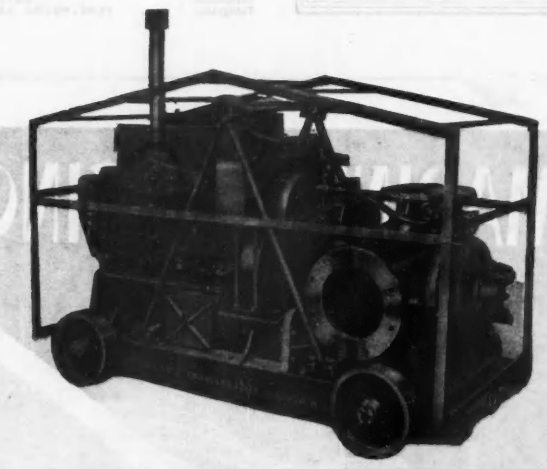

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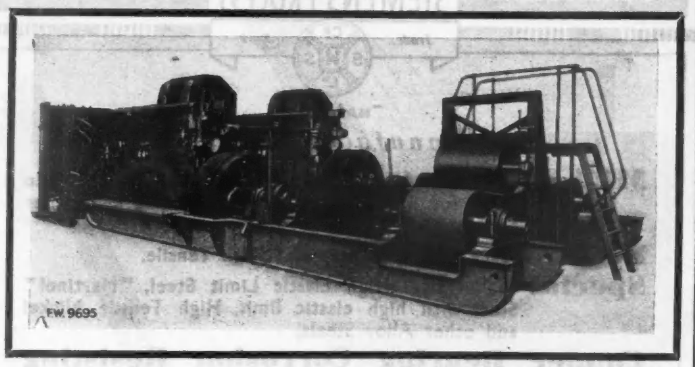

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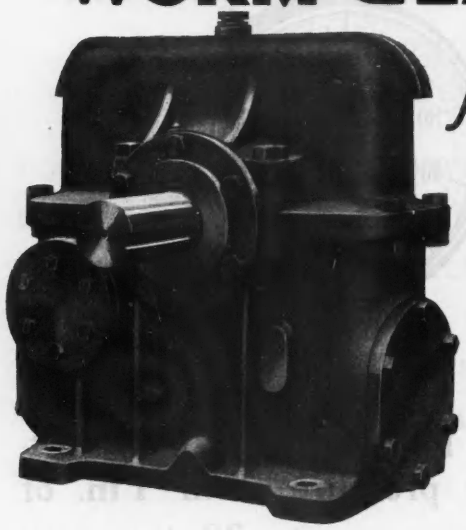

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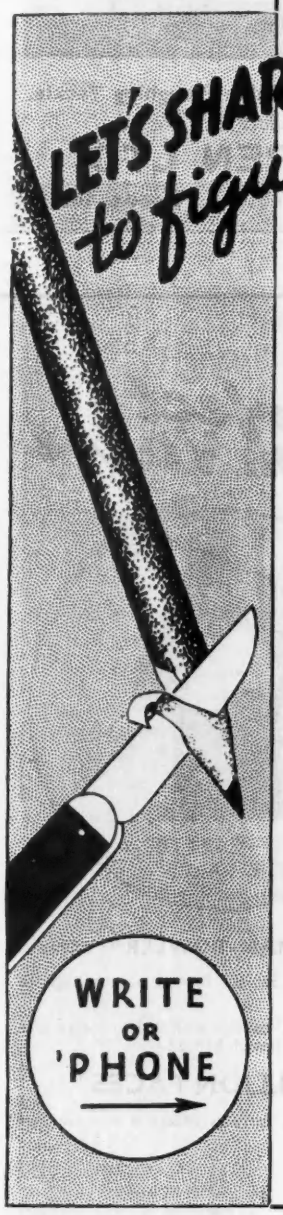

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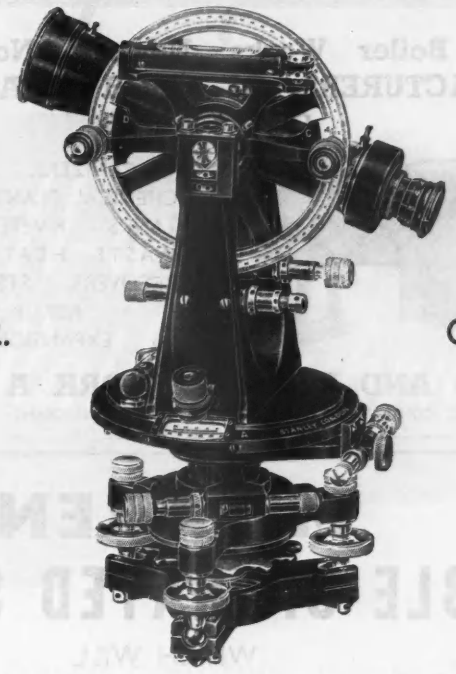

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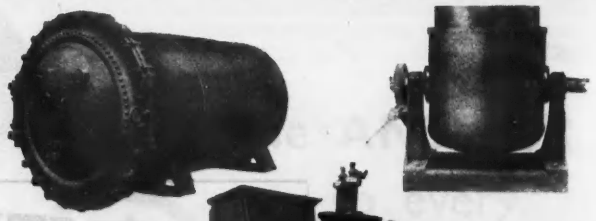

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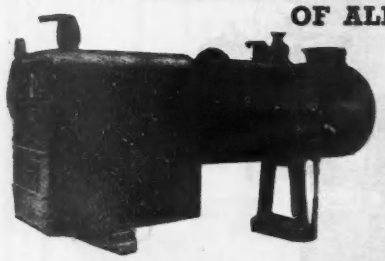

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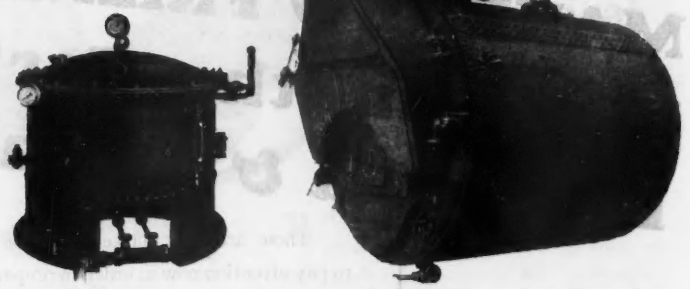

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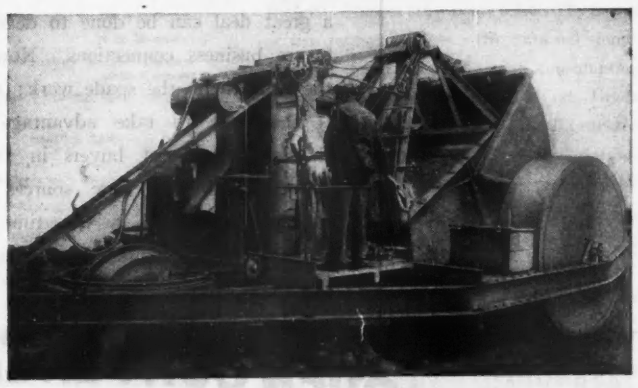

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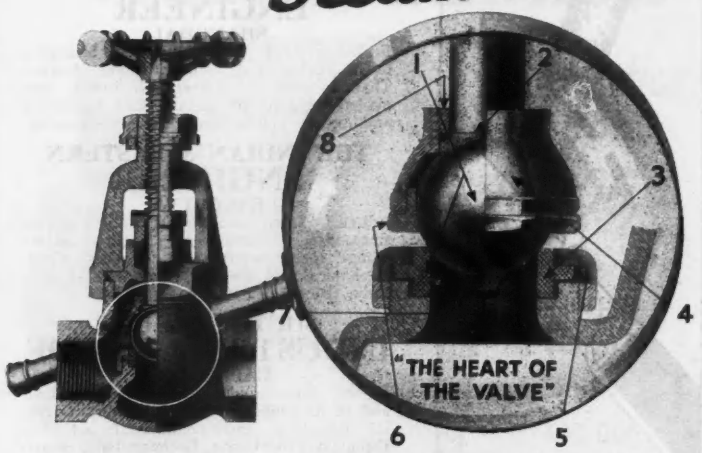

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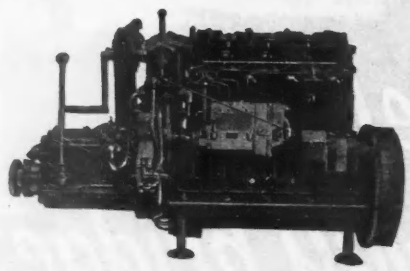

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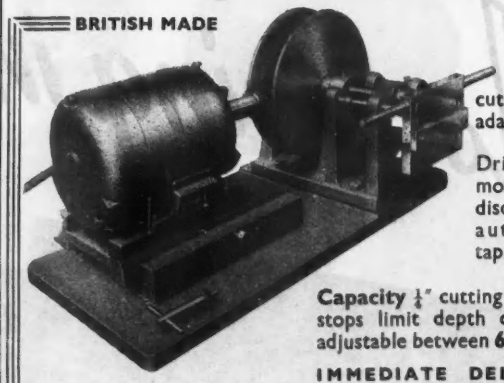

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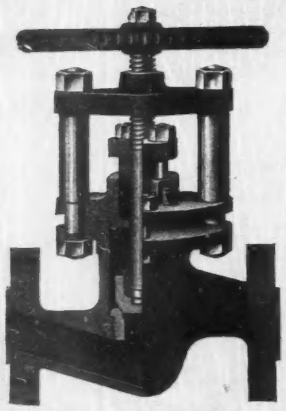

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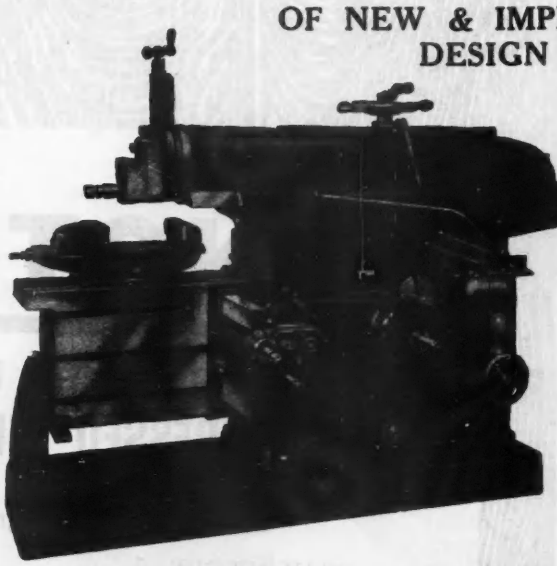

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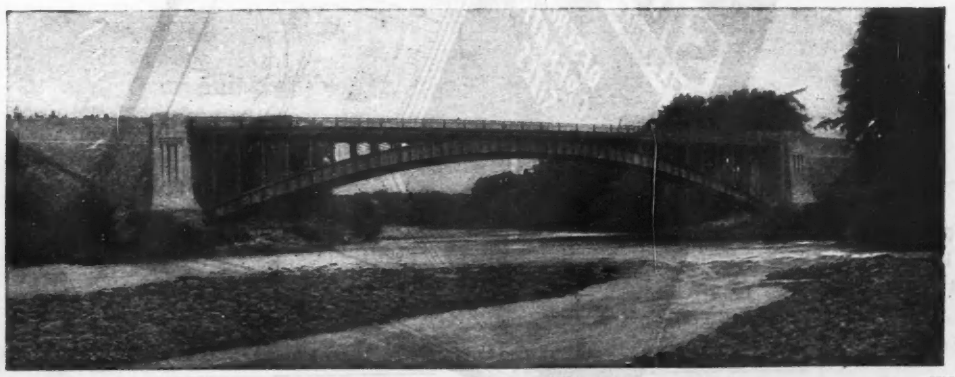

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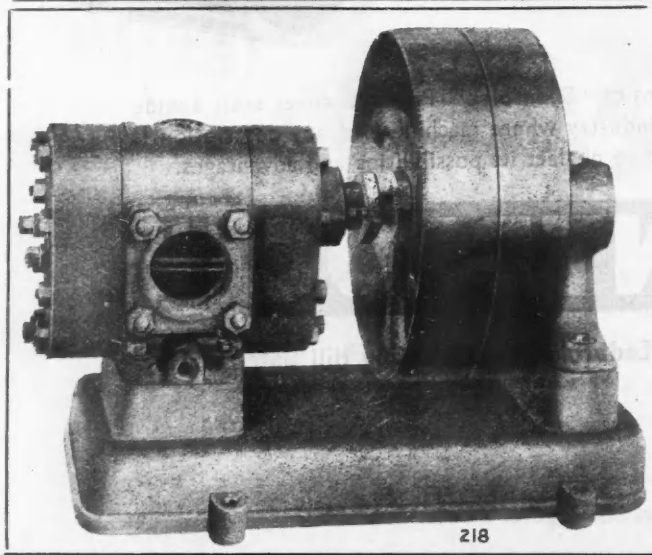

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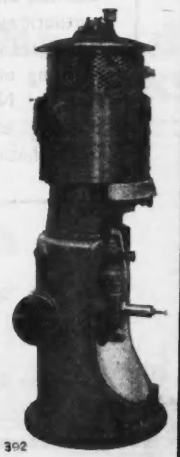

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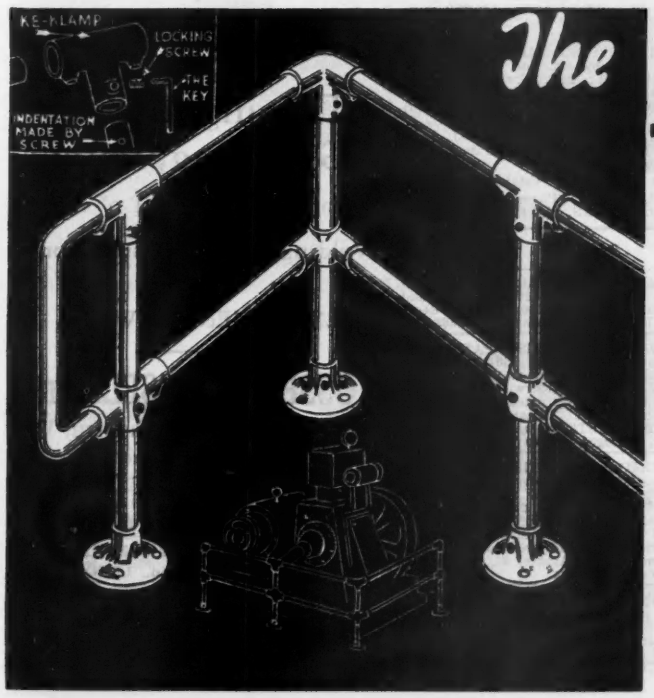

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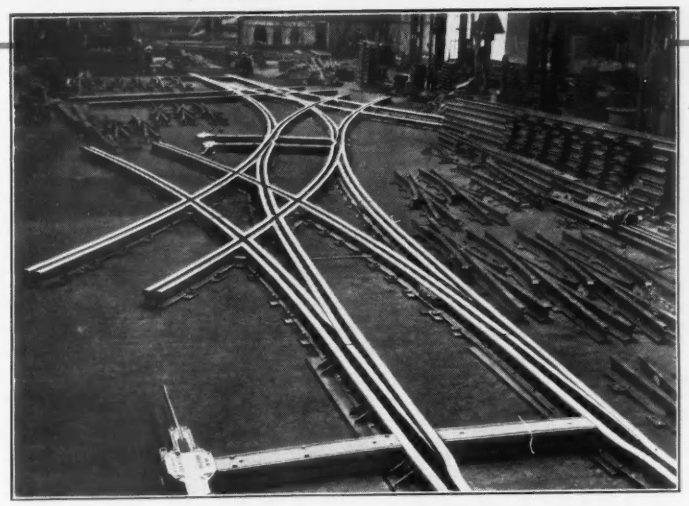

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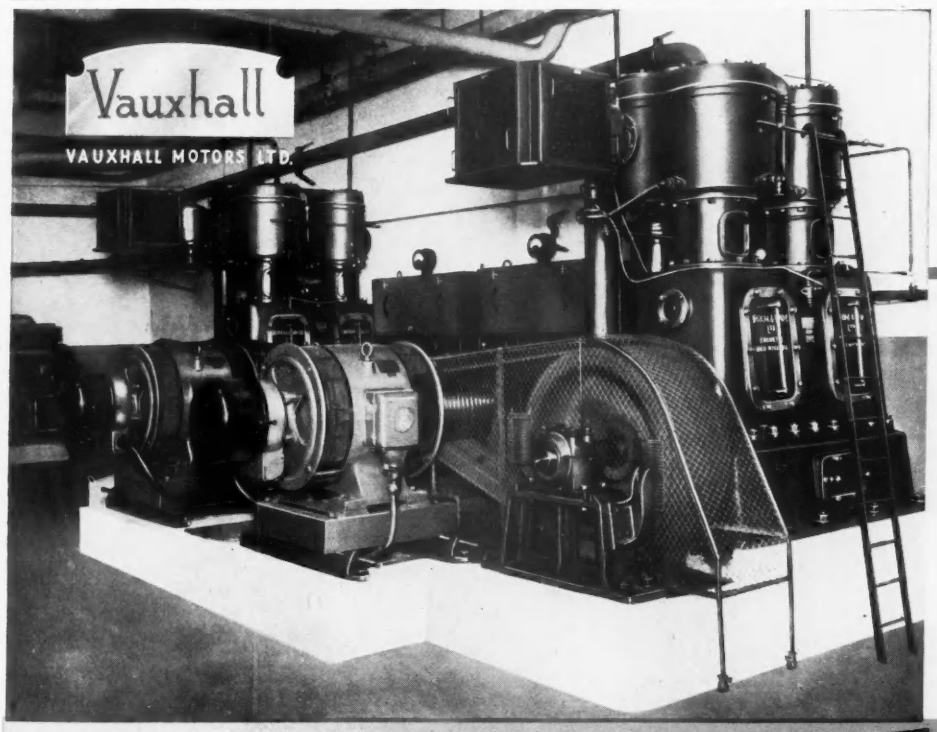

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